11 Measurement and Motion

Prior Knowledge

In the previous classes, I have learnt that

- Different modes of transport are used to travel from one place to another.
- Measuring things is very important in our day-to-day life.
- We use different measuring instruments to measure different things.
- Length is measured to know how long an object is.
- Objects are weighed to know the amount of mass contained in them.
- Liquids are measured using measuring containers.
- Time is measured in hours, minutes and seconds.
- Temperature of an object can be measured using thermometer.

Learning Objectives

In this chapter, I will learn about:

- History of transport
- Measurement
- Standard units of measurement
- Measurement of length
- Motion
- Types of motion

Let's Get Going

Look at the pictures and circle the odd one out. Explain your choice in the space provided below each set of pictures.

1. 

2. 

3. 

HISTORY OF TRANSPORT

Early humans used to travel by foot and carry their goods themselves. After a while, they started using animals to carry them and their goods from one place to another. Later, the invention of wheel changed the way people travelled. Carts drawn by oxen or horses were made to carry more people and goods. People used hollow wooden logs to travel across rivers. Later, they made boats to sail on water. Slowly, the invention of railways and steam engine changed the way the people and goods were transported from one place to another. Later, the invention of aeroplane by Wright brothers was a revolutionary step in the history of transportation.

At present, several advanced modes of transport such as cycle, bike, scooter, autorickshaw, bus, truck, train, ship, aeroplane and spacecraft are available for transportation.

Tech Updates

Transportation has become so advanced that we have reached to the space through spacecrafts. Astronauts who travel into space cannot throw their waste out into space, because it might hit a spacecraft. Therefore, empty cargo spacecraft is used to load waste and transported back to Earth. As it dives towards the ground, it gets so hot that it burns up.

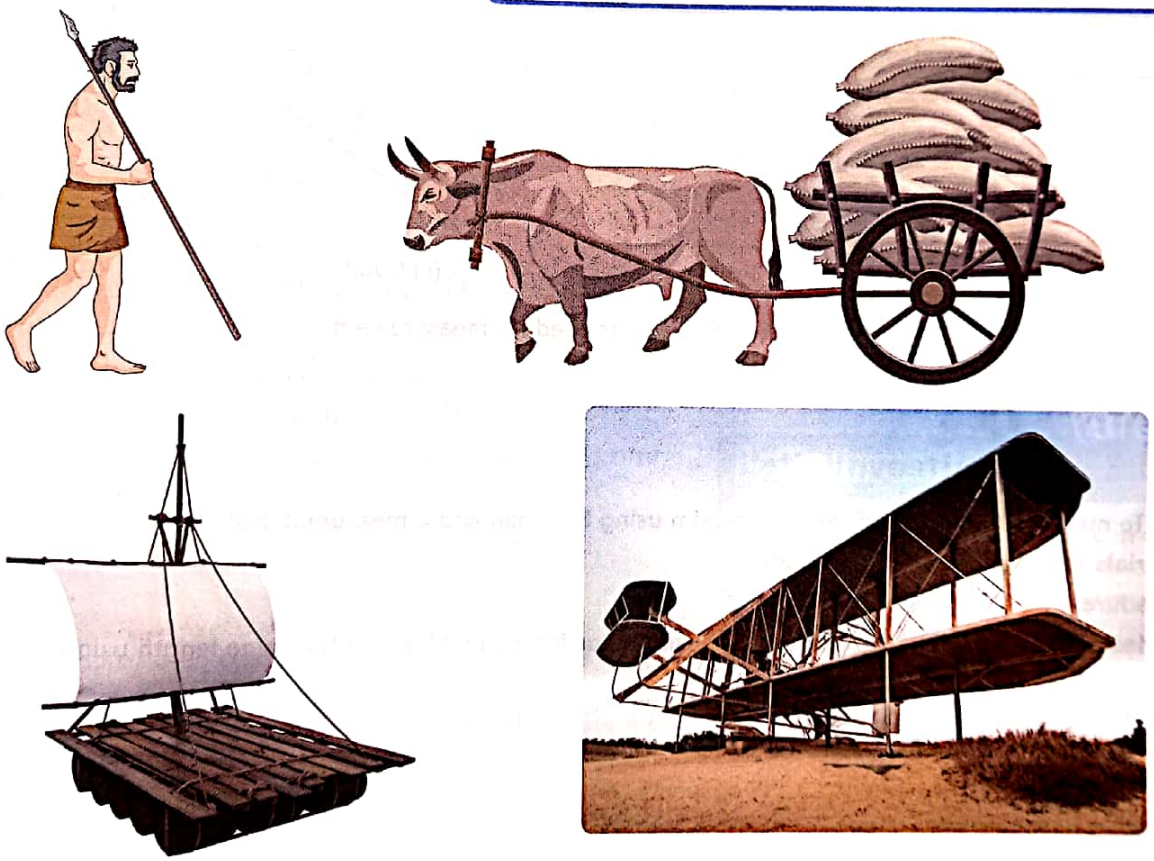


Fig. 11.1 History of transport

MEASUREMENT

The process of determining the length, size and amount of a physical quantity using specific devices is called **measurement**. A physical quantity has to be measured with respect to some fixed quantity. The fixed quantity we use to measure the physical quantity is called its **unit**. In order to measure any quantity, we should know the unit of measurement and the number of units that quantity measures. For example, if the measurement of a quantity is 10 cm, then cm is the unit and 10 is the number.

A unit is used as a standard of measurement.

In ancient times, people used different body parts such as handspan, footspan, cubit and pace for measurement.

Handspan: *Distance measured by a human hand from the tip of the thumb to the tip of the little finger when stretched, is called a* **handspan**. Using a handspan for measuring short lengths is a common practice even today. In your home you would have noticed your mother or grandmother measuring the length of a woollen sweater, using her handspan while knitting.

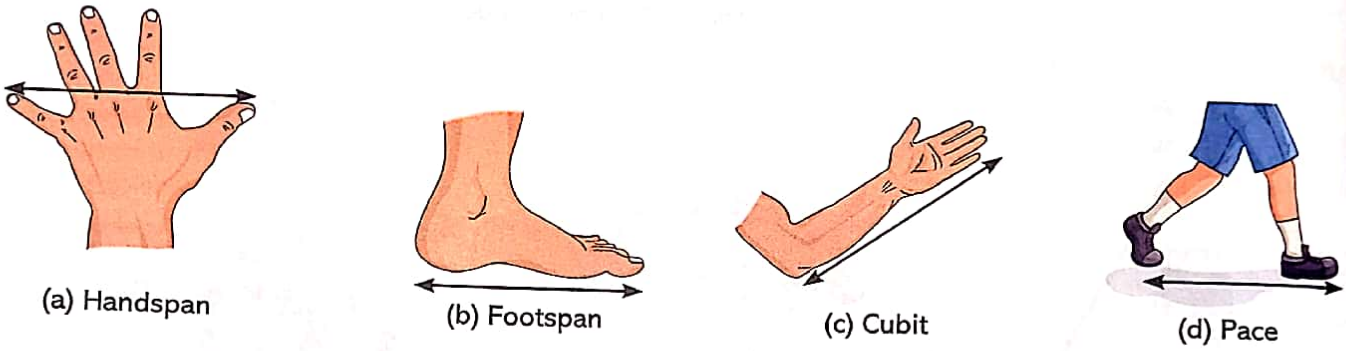
Let's Investigate

Measure the length of a desk in your classroom with your handspan. Ask two of your friends to do the same using their handspans. Compare the results. Is this method of measurement of length accurate?

Footspan: *The length between the toes and heel of a foot is called* **footspan.**

Cubit: *The length between the elbow and tip of middle finger of open palm is called a* **cubit.**

Pace: *One natural step (about 30 inches long) is called a* **pace.** One way to measure ground distance is the pace count.



(a) Handspan (b) Footspan (c) Cubit (d) Pace

Fig. 11.2 Body parts used for measurement

Let's Try

Aim: To measure the length of your classroom using footspan and a measuring scale

Materials required: A measuring scale

Procedure:

1. Measure the length of your classroom using your footspan. Measure the same length using a measuring scale.
2. Ask two of your friends to measure the length of the classroom using their footspans and then using a measuring scale.
3. Record all the measurements in the observation table and compare the results.

Observation table:

Name of the person	Measured value using footspan	Measured value using scale
Me		
Friend 1		
Friend 2		

From the above activity, we can conclude that the ancient methods of measurement are not reliable as the length of body parts varies from one person to another. Therefore, there is a need for standard units of measurement.

STANDARD UNITS OF MEASUREMENT

In 1670, the French astronomer and mathematician Gabriel Mouton created a standard set of units of measurement called the **metric system**. This system was standardized in Republican France in 1790.

Adopting standard units of measurement does not solve the problem. All over the world, people may be using different sets of standard units of measurement. For the sake of uniformity, scientists all over the world have accepted a common set of standard units of measurement called the **International Systems of Units** or the **SI units**. Scientists of different countries adopted the SI units in 1960.

The SI unit for length is metre, the SI unit of mass is kilogram and the SI unit of time is second.

People in different parts of the world also use other systems of measuring units such as the CGS system, MKS system and FPS system.

Table 11.1 shows the units of length, mass and time in different unit systems.

Table 11.1 Units of length, mass and time in different unit systems

System	Quantity		
	Length	Mass	Time
CGS	centimetre	gram	second
MKS	metre	kilogram	second
FPS	foot	pound	second

Remember

- The unit of a quantity is written in small letters.
- The symbol of a unit is also written in small letters. If it is named after a scientist, then it is written in capital letter.

Unit	Symbol
metre	m
kilogram	kg
second	s
kelvin (name of a scientist)	K

Based on the size of the object we need to measure, we choose an appropriate unit. The units millimetre and centimetre are used to measure shorter lengths, metre is used to measure lengths such as a piece of cloth. To measure very long distances such as the distance from one place to another, the unit kilometre is used.

Table 11.2 shows the commonly used units of length, mass and time.

Let's Investigate

How many millimetres are there in one metre?

Table 11.2 Commonly used units of length, mass and time

Length	Mass	Time
10 millimetre = 1 centimetre	1000 milligrams = 1 gram	1000 milliseconds = 1 second
100 centimetre = 1 metre	1000 grams = 1 kilogram	60 seconds = 1 minute
1000 metre = 1 kilometre	100 kilograms = 1 quintal	60 minutes = 1 hour
	10 quintals = 1 metric ton	24 hours = 1 day
		7 days = 1 week
		4 weeks = 1 month
		12 months = 1 year (365 days = 1 year)
		10 years = 1 decade
		10 decades = 1 century (100 years)
		10 centuries = 1 millennium (1000 years)

Measurement of Length

Length is the distance of something from one end to the other. It can be measured using a measuring scale (ruler) or a measuring tape. Vernier calipers and screw gauge are used to make accurate measurements.

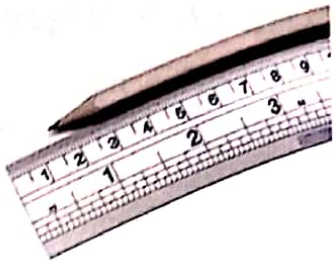


Fig. 11.3 A measuring scale or ruler

Correct measurement of length

The correct method of measuring length or distance is using the standard tools with correct markings for measurement. The scale in the geometry box can be used to measure the length of a pencil or book. While measuring the length using a scale, we should take care of the following points.

1. Ensure the scale is kept straight and aligned along the length of the object.
2. Place the scale on the object in such a way that zero of the scale is at the starting point from where the length is to be measured.
3. Ensure that the ends of the scale are not broken. If the edge of the scale is broken or worn out, start the measurement from any other clear marking. Later subtract the initial reading from the final reading. For example, if initial reading is 3 cm and final reading is 9 cm, then subtract 3 from 9. You will get the length of the object as 6 cm.
4. Also, ensure that your eyes are exactly above the point where the measurement is to be taken.

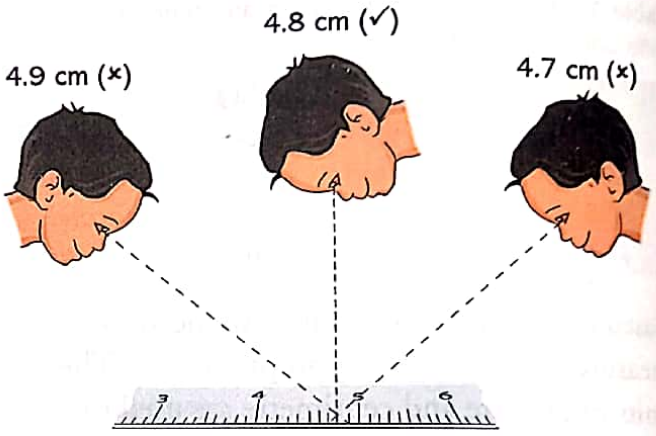
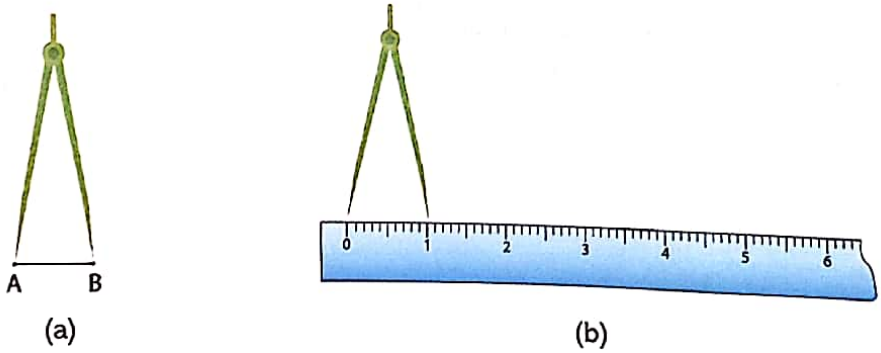


Fig. 11.4 The correct method of taking a measurement

Measuring length using a divider

A divider and a scale can be used to measure the distance between two points.

Keep the divider in such a way that each tip is at the points, say A and B as shown in Figure 11.5 (a). Then without disturbing the divider, place it on a scale as shown in Figure 11.5 (b). Take the readings corresponding to the tips of the divider. The difference between the readings gives the distance between the two points.



(a) (b)

Fig. 11.5 Measuring length using a divider

Measuring the length of the curved line

Can you measure the length of a curved line using a scale? It is not possible to directly measure the length of a curved line using a scale. A thread or a string can be used to measure the length of the curved line.

Take a thread and place it on the curved line. Mark the points where the curved line begins and ends on the thread. Stretch the thread along the length of a scale and measure the distance between the two marks on the thread.

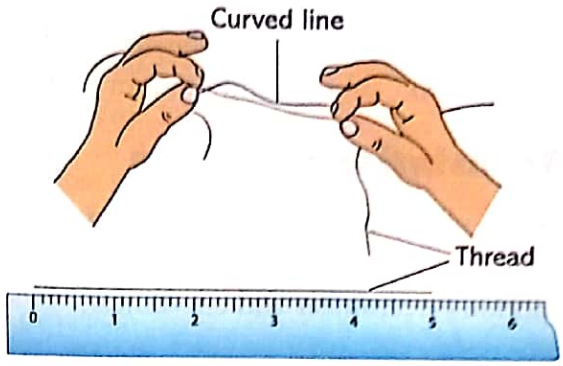


Fig. 11.6 Measuring length of a curved line using a thread and a scale

Importance of Estimations

In many cases, we need accurate measurements of physical quantities. Hence, to be accurate, special devices are used. For example, to measure fractions of time, we use stop watch that can show time in milliseconds. To measure mass of finite objects, we use physical weighing. However, in some cases, accurate measurements are not required. For example, to measure the distance of the nearest bus stand from your place, accuracy in terms of millimetres or metres is not required. An approximate value of the distance is sufficient. This method of assuming the value of a measurement is called **estimation**. Estimation is useful in many situations in our life.

Real World

The time-keeping services in India are provided by the National Physical Laboratory, New Delhi. The clock they use can measure time intervals with an accuracy of one-millionth of a second. The most accurate clock in the world has been developed by the National Institute of Standards and Technology in USA. This clock will lose or gain one second after running for 20 million years.

Knowledge Check

Fill in the blanks using the words given in the box.

metre	ten	thread	scale	footspan	cubit	1790

1. The SI unit of length is _____.
2. Metric system was standardized in Republican France in _____.
3. One decade has _____ years.
4. Length of a curved line can be measured using _____ and _____.
5. _____ and _____ are the ancient methods of measuring length.

MOTION

Anything that moves is said to be in motion.

An object is said to be in **motion** when it changes its position with respect to its surroundings.

An object is said to be at **rest** when its position does not change with time with respect to its surroundings.

Let us study more about motion and its types.

Types of Motion

The motion of objects can be classified as translational motion, rotational motion, periodic motion, non-periodic motion and random motion.

Translational motion

When all the parts of an object move equal distances in equal intervals of time, the object is said to be in **translational motion**. For example, a car moving on a road. There are two types of translational motion—rectilinear and curvilinear.

Rectilinear motion

When an object moves in a straight line, it is said to be in **rectilinear motion** (Fig. 11.7). In this type of motion, the direction of the motion of an object remains the same. For example, a truck moving on a straight road and an athlete running on a straight track.

Curvilinear motion

When an object moves along a curved path, it is said to be in **curvilinear motion** (Fig. 11.8). In this type of motion, the direction of the motion of an object changes with time, but its orientation remains the same. For example, a bus moving on a curved road and a stone thrown up in the air at an angle.

Fig. 11.7 Rectilinear motion

Fig. 11.8 Curvilinear motion

Rotational motion

When an object moves about an axis and all the parts of it do not move the same distance in a given interval of time, it is said to be in **rotational motion** (Fig. 11.9). For example, rotation of the Earth about its axis and rotational motion of blades of a fan.

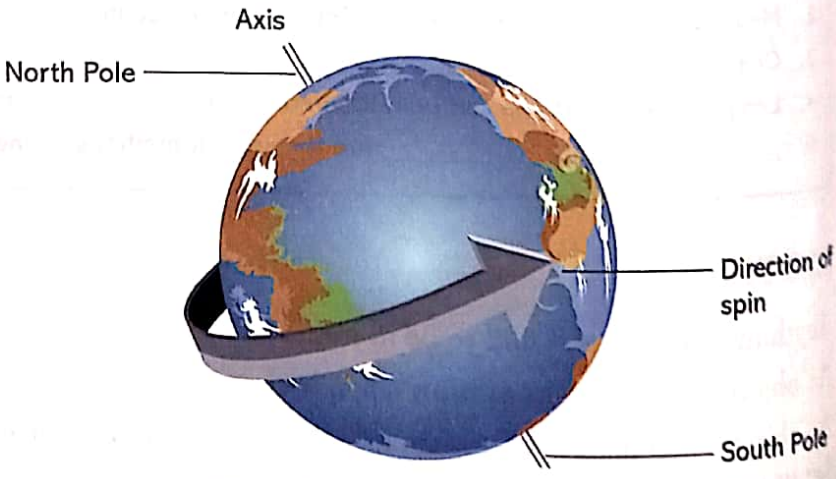


Fig. 11.9 Rotational motion

Periodic motion

When an object repeats its motion along the same path at regular intervals of time, it is said to be in **periodic motion.**

For example, motion of moon around the Earth, motion of pendulum and motion of hands of a clock (Fig. 11.10).

Fig. 11.10 Periodic motion

Real World

The to and fro motion of an object from its position of rest is called oscillatory motion. Swing and pendulum of a clock show oscillatory motion.

Non-periodic motion

When an object does not repeat its motion at regular intervals of time, it is said to be in **non-periodic motion.** For example, children playing in the park and a car moving on a road.

Random motion

When the motion of an object has no fixed direction, and is in a zig-zag manner, it is called **random motion** (Fig. 11.11). For example, motion of the dust particles in air and the motion of insects.

Combination of Different Types of Motion

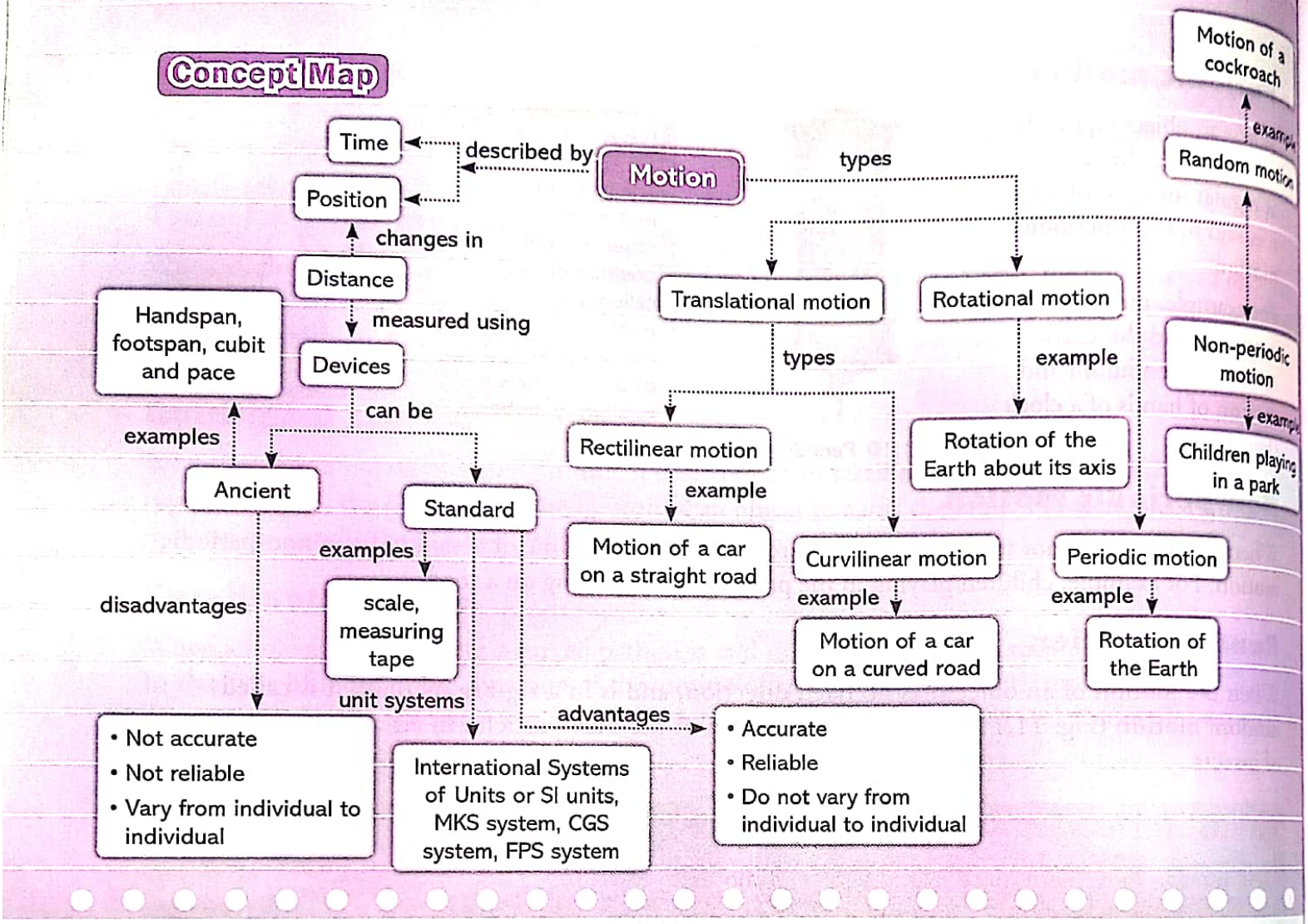
An object can move with more than one type of motion.

For example, the wheels of a moving bicycle undergo rotational motion whereas the cycle is in translational motion at the same time (Fig. 11.12). The birds gliding across the sky undergo translational as well as non-periodic motion. As the Earth rotates on its axis, it undergoes rotational as well as periodic motion.

Fig. 11.11 Random motion

Fig. 11.12 Motion of a bicycle

Concept Map



Keywords

Measurement: The process of determining length, size and amount of a physical quantity using specific devices
Motion: When an object changes its position with respect to its surroundings
Rectilinear motion: Motion of an object in a straight line
Curvilinear motion: Motion of an object along a curved path
Periodic motion: Motion that repeats itself after regular intervals of time

Summary

a. **In this chapter, I have learnt that**

- ☐ Various means of transport are used to travel since ancient times.
- ☐ Different means of measuring time, length and distance are used.
- ☐ Motion can be of different types.
- ☐ More than one type of motion can be used by a moving object.

b. **I can do the following:**

- ☐ Use different methods to take measurements
- ☐ Make estimations for measuring different things
- ☐ Differentiate among different types of motion