12 Earth, Moon, and the Sun

One morning in Kanniyakumari, Tamil Nadu, 12-year-old Rashmika was eagerly cycling to school. She was excited. That was the day her science teacher had dedicated a class for students to share and try to explain interesting observations.

Rashmika had been noticing that the coconut tree shadows were long in the morning but shorter in the afternoon on her way back. She thought about it and decided that the size of the shadows changed because the Sun moved across the sky during the day. But she also remembered learning that the Earth moved around the Sun (in chapter ‘Beyond Earth’ in the Grade 6 Science textbook *Curiosity*) so she was puzzled. She wondered—does the Sun move in the sky? Or does the Earth move?

12.1 Rotation of the Earth

You might have also noticed that the Sun rises in the East and sets in the West. Have you ever wondered why? Let us try to understand why. Have you ever enjoyed riding a merry-go-round at a park or at your school? Let us go back to riding a merry-go-round!

Activity 12.1: Let us explore

- Sit on a merry-go-round facing towards the outer side as shown in Fig. 12.1.

Fig. 12.1: A girl observing objects around her while riding a merry-go-round

- Ask someone to turn the merry-go-round slowly in the anti-clockwise direction as shown in Fig. 12.1. While you are sitting on the moving merry-go-round, look around you. Do the objects around you appear to be moving? In which direction do they appear to be moving?

While you turn in the anti-clockwise direction, the objects appear to turn around you in the opposite direction, that is, in the clockwise direction.

- Now fix your gaze at a particular tree (or a building) ahead of you while sitting on the merry- go-round turning around in anti-clockwise direction.

In which direction do you find the tree turning around you? Is it in your view all the time?

The tree appears to turn around you in the opposite direction, that is, the clockwise direction. The tree appears in your view from your left-hand side and then moves out of your view on the right-hand side when you view it from a merry-go-round turning around in anti-clockwise direction.

Using the observations made by us while riding a merry-go-round, let us now think. When we view from the Earth, the Sun appears in the East, moves across the sky from the East to the West and disappears in the West. Does it indicate that the Sun is moving in the sky? Or might it be that the Earth itself is turning around and the Sun just appears to move?

The fact is that the Sun appears to be moving because we view it from the Earth, which is turning around itself.

In which way is the Earth turning around itself? To visualise this, let us recall some of the objects which turn around themselves. Have you watched a top spinning around its spindle (Fig. 12.2a)? Or a spinning fan (Fig. 12.2b)? Or tried spinning a ball (Fig. 12.2c)?

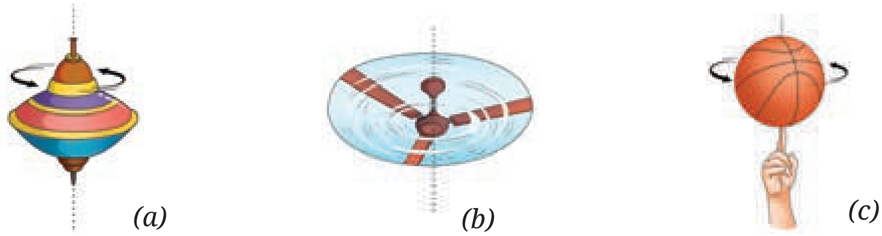


Fig. 12.2: (a) A spinning top (b) A spinning fan (c) A spinning ball

In a similar manner, the Earth also spins (or **rotates**) on its own axis in space as shown in Fig. 12.3. The **Earth's axis of rotation** passes through its geographic North Pole and the South Pole. The Earth completes **one rotation** in about 24 hours.

When viewed from the top of the North Pole (Fig. 12.3), the Earth is rotating in the anti-clockwise direction, that is, from West to East.

Let us try to understand this with the help of a globe. You have used a globe in Grade 6 to represent the Earth and identified North Pole, South Pole, and Equator on it. You also learnt that its axis passed through its North and South poles (in the Grade 6 Social Science textbook *Exploring Society India and Beyond*).

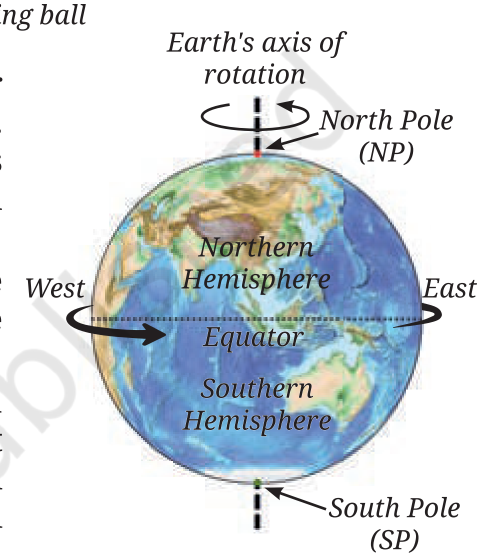


Fig. 12.3: Rotation of the Earth

Activity 12.2: Let us explore

❖ Use a globe to represent the Earth and place a small sticker to mark your location on it (Fig. 12.4a).

❖ While viewing from above the North Pole, slowly rotate the globe on its axis in anti-clockwise direction.

❖ **Observe** how your location turns around and finally comes back to its original position completing one rotation.

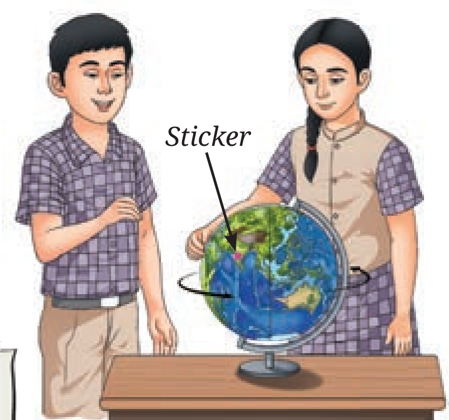
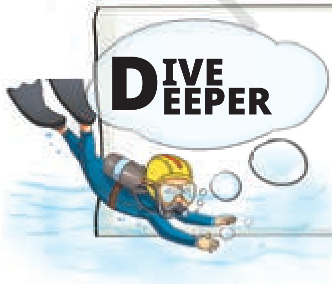


Fig. 12.4(a): Using a globe to understand rotation of the Earth



Rotation is the motion of an object in which all its parts move in circles around an imaginary line that passes through it. This line is called the axis of rotation.

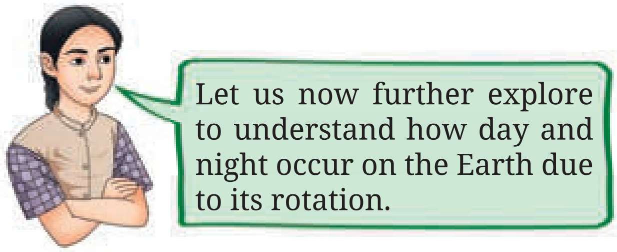


Fig. 12.4(b): Using a globe and a torchlight to understand day and night

- ❖ Use a torch to represent the Sun. Go to a relatively dark room to carry out the further steps of the activity.
- ❖ Now, shine light from the torch placed at some distance, say 1.5 metres, on the globe as shown in Fig. 12.4b. Do you **notice** how half of the globe receives the light from the torch, while the other half stays dark?

It is day time in that half of the globe which receives light, and night time in the other half.

- ❖ In India, sunrise first occurs in the eastern part and then in other parts. While looking at the eastern part of India on the globe, rotate the globe in one direction and then in the opposite direction. What is the direction of rotation when light falls on the eastern part of India first?

The light falls on the eastern part of India first when the globe rotates from West to East with respect to the North-South axis of the globe.

- ❖ Now while rotating the globe from West to East, observe your location on the Earth. Does it go through a cycle of day and night?

Sunrise occurs as your location moves into light and sunset occurs as it moves into darkness.

The Earth's rotation from West to East causes the day-night cycle. As shown in Fig. 12.5, the side facing the Sun experiences daytime, while the other side is dark and experiences night.

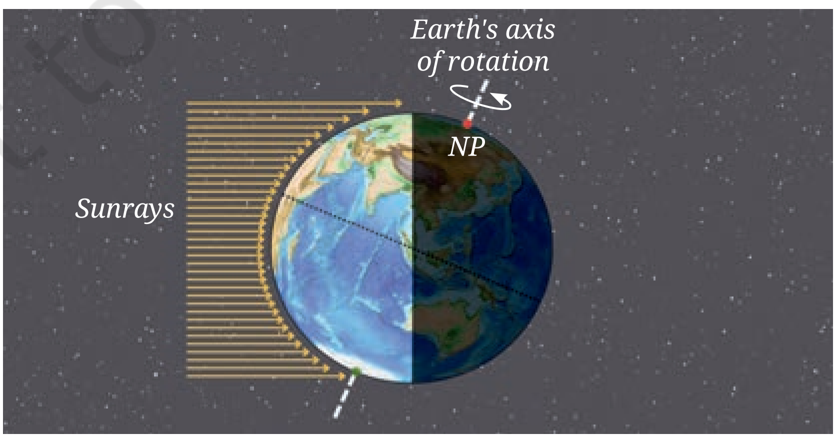


Fig. 12.5: Sunlight falls on half of the Earth's surface

Now **imagine** that you are standing on the Equator on the Earth and watching the sky during one rotation of the Earth while it rotates from West to East. What will you observe? Will your observation be the same as that of the girl shown in Fig. 12.6?

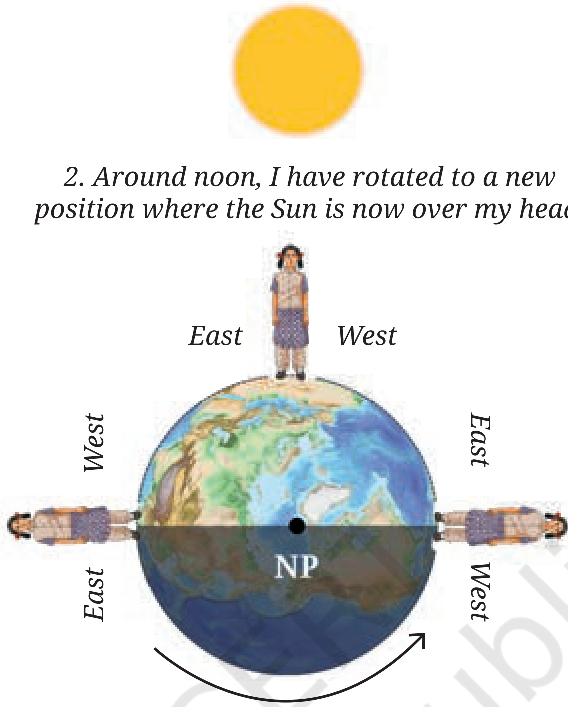
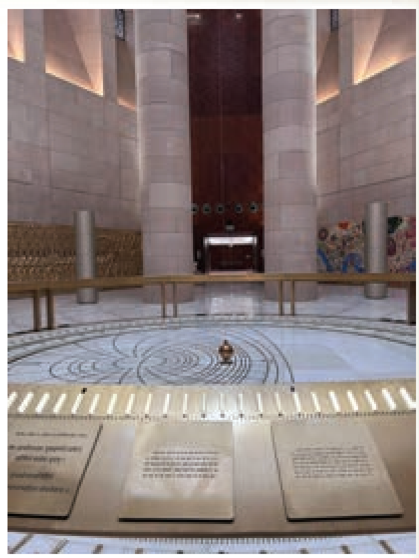


Fig. 12.6: A girl on the rotating Earth viewing the Sun from the Equator

Due to the rotation of the Earth, the Sun appears to rise in the eastward direction, move across the sky from the East to the West and set in the westward direction (Fig. 12.6). Then the night begins and the stars become visible in the sky.

Fascinating Facts



In an earlier chapter 'Measurement of Time and Motion', you learnt how the scientist Galileo discovered an important property of a pendulum, and in the seventeenth century, another scientist, Huygens, used that property to make pendulum clocks that measured time. In the middle of nineteenth century, another scientist, Leon Foucault, used a long pendulum to give the first simple demonstration of the Earth's rotation. The pendulum, known as a Foucault pendulum in his honour, consists of a long string with a heavy bob, suspended from a high ceiling.

A Foucault pendulum with a length of 22 metres has been hung from a skylight in the Constitution Hall of the new Parliament building in New Delhi, India. It symbolises the integration of the idea of India with the vastness of the cosmos.

Since the Earth is rotating, shouldn't the stars also appear to move in the sky like the Sun?

Yes, indeed! Let us look at the stars in the night sky to see the effect of Earth's rotation.

Activity 12.3: Let us explore

- ❖ On an early evening between March and May, **identify** the Big Dipper (Saptarishi), and the Pole Star (Dhruva Tara), if visible, as you did in the chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity*.

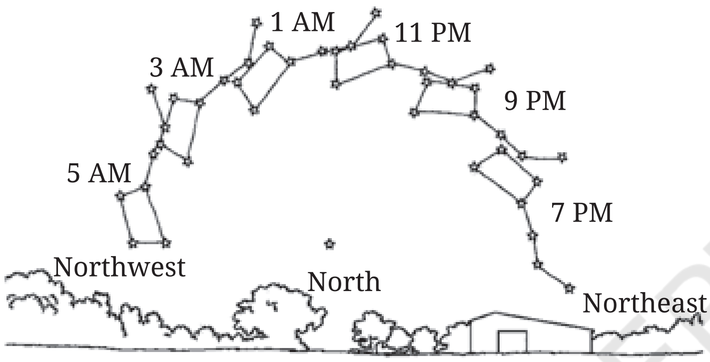


Fig. 12.7: Illustrative sketch of Big Dipper (for activity 12.3) by a student located in Pune on the night of 1–2 April

- ❖ Note down your location and date of your night sky observations. The activity must be carried out on the same night.
- ❖ **Draw** the orientation of the Big Dipper in the sky with respect to the Pole Star (or a fixed tree/building on the ground in a direction towards the Big Dipper if you cannot see the Pole Star). Mark the time of your observation along with your sketch as shown in Fig. 12.7.
- ❖ After two hours, observe the Big Dipper again. Has it moved? Again, draw its orientation and note down the time.
- ❖ Repeat the above step after two hours. Do you observe that the Big Dipper appears to move around the Pole Star (notice just the movement even if you cannot see the Pole Star)?

The Earth's axis of rotation points very close to the Pole Star in the Northern Hemisphere. Therefore, the Pole Star appears nearly stationary in the sky from the Earth. All the stars appear to move around it. Just like the Sun, the Moon also appears to rise in the eastward direction and set in the westward direction because the Earth rotates from West to East.

(Picture taken from Mahuli, Maharashtra)

Fascinating facts

Astrophotographers take long exposure photographs, keeping the camera's shutter open for a long time. In such a photograph, the apparent motion of the stars is recorded as arcs of a circle, known as star trails.

Fascinating Facts

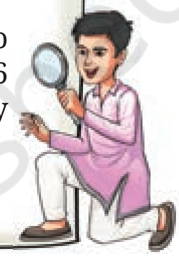
Ancient Indian astronomers, including Aryabhata, had also noticed the daily apparent motion of the celestial objects, such as the Sun, Moon, planets and stars. Aryabhata was a famous mathematician and astronomer of ancient India who wrote an important treatise, *Aryabhatiya*, around the fifth century CE. The apparent motion of the stars due to the rotation of the Earth is explained in Verse 9, Golapada, *Aryabhatiya*.

अनुलोमगतिर्नौस्थः पश्यत्यचलं विलोमगं यद्वत्।

अचलानि भानि तद्वत् समपश्चिमगानि लङ्कायाम्॥

Just as a man in a boat moving forward sees stationary objects as moving backwards, so also the stars that are stationary are seen by people of Lanka as moving towards the west.

Aryabhata's stated value for the time taken by the Earth to complete one full rotation about its axis is around 23 hours 56 minutes 4.1 seconds (in modern units). This value is impressively close to the currently accepted value.



I have seen that the stars and constellations that appear in the East at sunset change during different months.

Yes. Maybe that is why we were told to look for certain stars and constellations at certain times of the year in Grade 6. But, why do different stars appear in the night sky over the course of a year?

12.2 Revolution of the Earth

While rotating on its own axis, the Earth also revolves around the Sun as we learnt in Grade 6. This movement is different from rotation. **Revolution** is the motion of an object around another object.

The path an object takes while revolving around another object is called its **orbit**. If viewed from the top (Fig. 12.8), the orbit of the Earth around the Sun is nearly circular. (In the figure of the Solar System given in chapter 'Beyond Earth' in the Grade 6 Science textbook *Curiosity*, the orbit appeared elongated because it was a side view of the orbit). The Earth completes **one revolution** around the Sun in about 365 days and 6 hours.

12.2.1 Changing view of night sky from the Earth

Every evening the Sun sets in the westward direction and the night sky becomes visible. We know that this occurs due to the Earth's rotation. As the Earth also revolves around the Sun continuously, the stars seen in the night sky after sunset gradually change over a year as we look in different directions, as shown in Fig. 12.8.

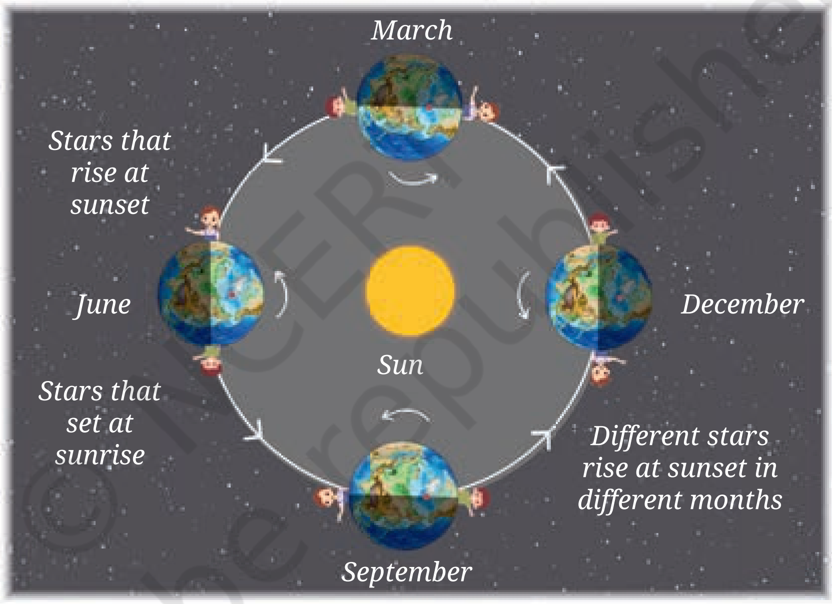


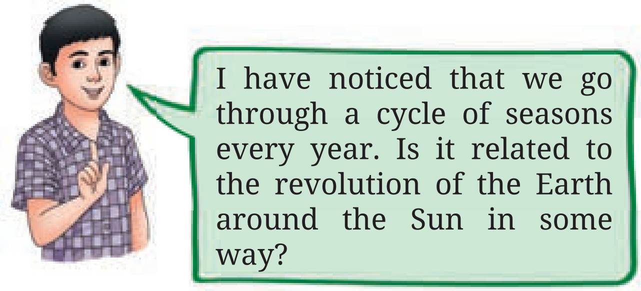
Fig. 12.8: Revolution of the Earth around the Sun leads to changing view of the night sky throughout the year (The sizes and distances are not to scale)

You can also notice this change by looking at the pattern of stars (such as those that you learnt about in Grade 6), at a fixed time of the night, on days separated by a month.

FASCINATING FACTS

The *Bhil* and *Pawara* are indigenous communities from the Tapi Valley in western India, who used the appearance of certain patterns of stars in the sky as markers for the arrival of monsoon rain.

12.2.2 Seasons on the Earth



The Earth's axis of rotation is not upright with respect to the orbit, but is tilted. The Earth maintains this tilt as it orbits around the Sun (Fig. 12.9). The tilt of the Earth's axis and the spherical shape of the Earth gives rise to seasons. Let us find out, how.

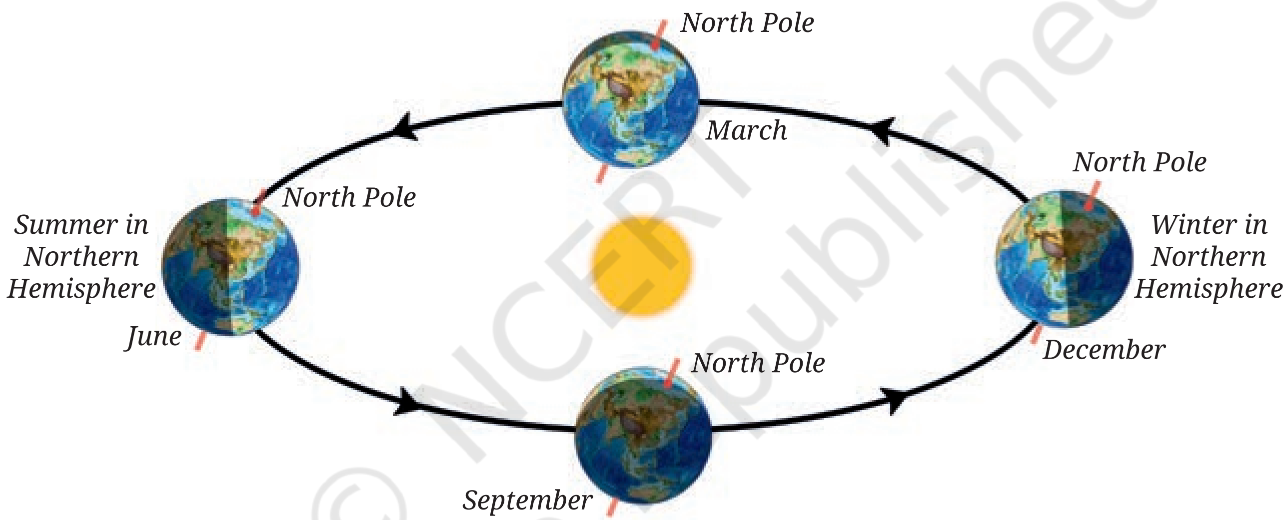


Fig. 12.9: Different positions of the Earth while revolving around the Sun (The Earth's orbit appears elongated because this is a side view and not the top view. The sizes and distances are not to scale)

In June, the Northern Hemisphere is tilted towards the Sun while the Southern Hemisphere is tilted away from the Sun (Fig. 12.9). As seen in Fig. 12.10a, a given amount of sunrays are spread in a smaller area in the Northern Hemisphere as compared to the Southern Hemisphere due to the spherical shape of the Earth's surface. So that area is heated more.

Further, the Northern Hemisphere receives sunlight for more than 12 hours in June (Fig. 12.11a). So, the Northern Hemisphere experiences more intense sunlight, which lasts for a longer time, causing the summer season. In December, the situation is opposite in the Northern Hemisphere and it experiences winter season with sunlight for shorter time (Fig. 12.10b and Fig. 12.11b).

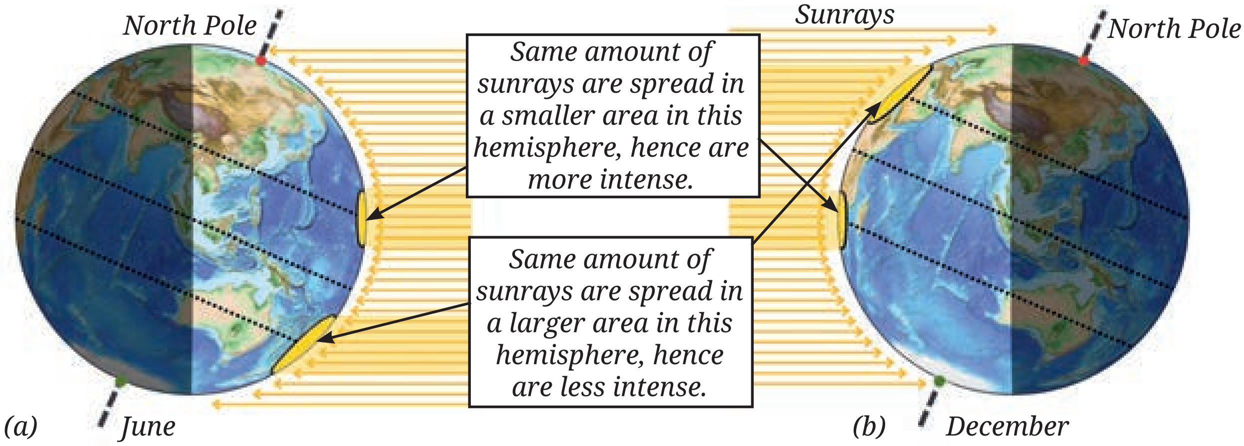


Fig. 12.10: (a) More intense sunlight in the Northern Hemisphere and less intense sunlight in the Southern Hemisphere in June (b) The opposite situation happens in December.

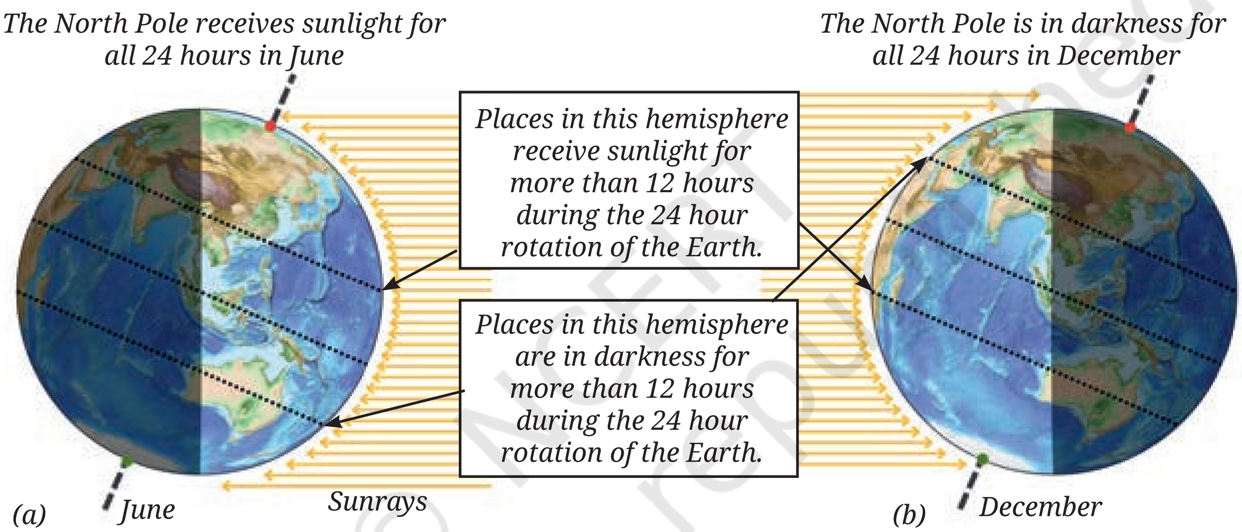
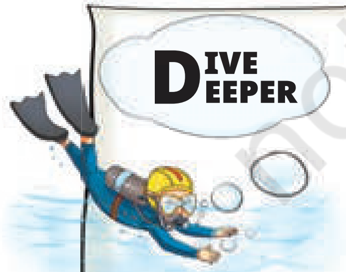


Fig. 12.11: In the Northern Hemisphere (a) Longer daytime in June (b) Shorter daytime in December

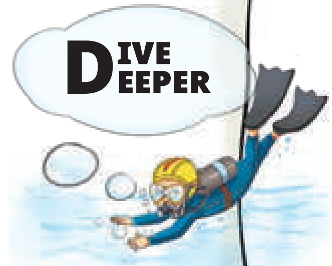
The seasons and length of daytime are reversed in the Southern Hemisphere as compared to the Northern Hemisphere. There, it is winter in June and summer in December (Fig. 12.10 and Fig. 12.11).



Two incorrect reasons often given to explain why seasons occur on the Earth are:

- ❖ When the Northern Hemisphere tilts towards the Sun, it is closer to the Sun.
- ❖ The orbit of the Earth is an oval with the Sun slightly displaced from its centre so the Earth is at different distances from the Sun over the year.

However, the difference in distances in either of these cases is very small and these are not the reasons why seasons occur on the Earth. In fact, the Earth is closest to the Sun in January.



In the Northern Hemisphere, the longest day occurs around 21 June—this is known as summer solstice. After the summer solstice, the duration of a day becomes shorter while that of a night becomes longer. The shortest day and longest night in this Hemisphere occur around 22 December known as the winter solstice. Around 21 March and 23 September, the daytime lasts for 12 hours. In the Northern Hemisphere, these days are called the spring and the autumn equinox, respectively.

Fascinating Facts

At the North Pole, the Sun rises in the East direction on the equinox day—21 March, and remains continuously in the sky for six months. The Sun sets on 22 September. The South Pole experiences the opposite behaviour. The polar regions thus experience continuous sunshine for six months followed by a six-month period of darkness.

On the equator, there is always 12 hours of sunlight and 12 hours of darkness. There is little difference in the intensity of the sunrays falling on the equator in different months. Thus, for the southern states of India that lie close to the equator, the effect of seasons is not very prominent. Other effects, such as local geographical features and proximity to oceans or seas, can also influence these broader patterns seen in the two hemispheres, as you have learnt in social science.

12.3 Eclipses

Day and night cycle, seasons, the life on the Earth... so much is dependent upon the Sun. Could the light from the Sun get blocked by the two planets which are revolving between the Earth and the Sun?

The planets Mercury and Venus appear very small compared to the Sun, and never block the entire light from the Sun reaching us. However, you may be surprised to know that the Moon can do that. Do you remember studying in Grade 6 that the Moon is a natural satellite of the Earth and it revolves around the Earth as the Earth revolves around the Sun?

12.3.1 Solar eclipse

At certain times, the Moon can come in between the Sun and the Earth in a way that obstructs the light from the Sun from reaching us. This is known as a **solar eclipse**. You may wonder how the Moon, which is smaller than the Sun, blocks the light coming from the Sun that we see in the sky.

Activity 12.4: Let us explore

- Ask your friend to stand in front of you at a distance of about 5 metres. Consider his head to be the Sun.
- Now close one eye and show a thumbs up with your outstretched hand towards your friend as shown in Fig. 12.12. Are you able to cover the entire head of your friend with your thumb?

Fig. 12.12: Trying to cover a friend's head with the thumb

You can cover the entire head of your friend with the help of your thumb, even though your thumb is much smaller than the actual size of your friend's head. How could it be? The size of any object as seen by your eye—also known as **apparent size**—depends upon both its actual physical size and its distance from you. The thumb being much closer to you as compared to your friend, the apparent sizes of your thumb and your friend's head as seen by you in Activity 12.4 are similar.

The apparent sizes of the Moon and the Sun in the sky are similar when viewed from the Earth. This is so because though the Moon is much smaller in physical size than the Sun, the Moon is much closer to us compared to the Sun. Therefore, the Moon can appear to cover the entire Sun as viewed from the Earth.

DIVE DEEPER

Though the planets Mercury and Venus are much larger than the Moon in size, they are also much farther from the Earth as compared to the Moon. Thus, their apparent sizes are very much smaller than the Sun and they cannot block the Sun. For example, when Venus passes between the Sun and the Earth, it appears as a tiny black dot passing against the bright face of the Sun. This event, known as a Transit of Venus, is a rare event.

Figure 12.13 shows the arrangement of the Sun, the Moon, and the Earth during a solar eclipse. The shadow of the Moon falls on a small area on the surface of the Earth as seen in Fig. 12.13. This area is in total darkness, and no part of the Sun can be seen from there. The observers in this area witness a **total solar eclipse** (Fig. 12.14a).

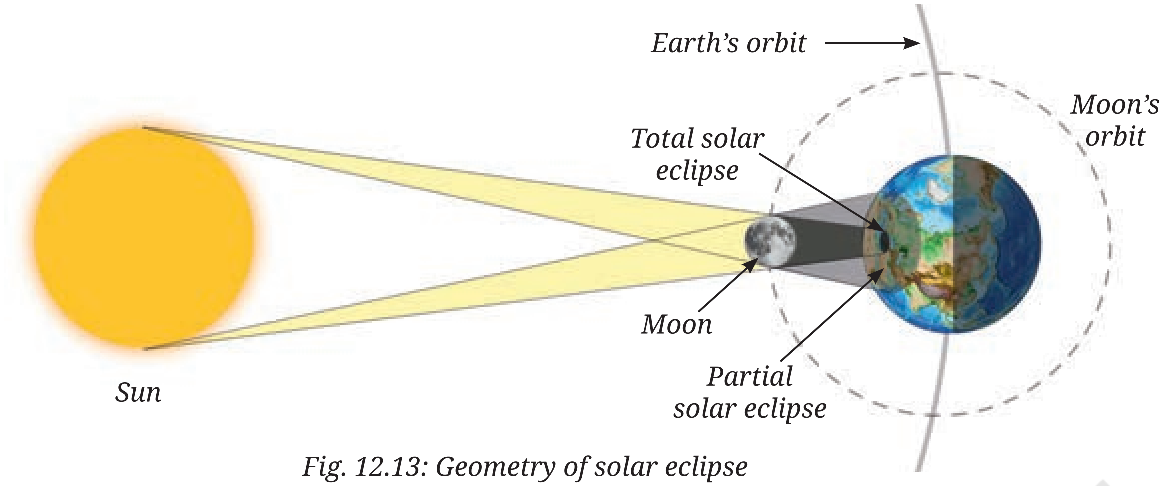
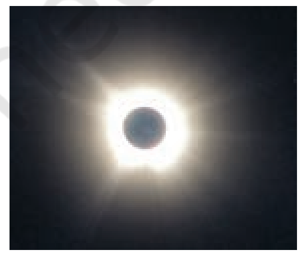


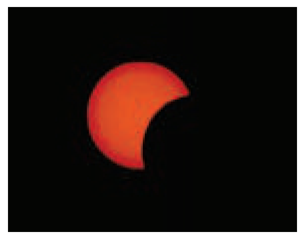
Fig. 12.13: Geometry of solar eclipse (The sizes and distances are not to scale)

In areas where the Moon partially blocks out only some regions of the Sun, the observers see a **partial solar eclipse** (Fig. 12.13 and Fig. 12.14b).

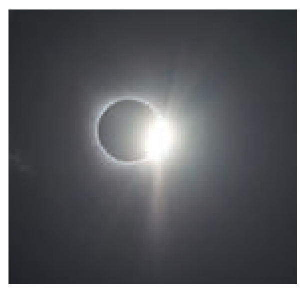
During a total solar eclipse, for a few minutes it turns dark during the day as no sunlight reaches the Earth. Due to the Earth's rotation and the motion of the Moon in its orbit, the Moon's shadow moves across the surface of the Earth. Thus, the total solar eclipse is visible only for a few minutes. As the Moon begins to move away from the front of the Sun (Fig. 12.14c), we see a partial solar eclipse and daylight begins to return.



(a) Total solar eclipse



(b) Partial solar eclipse



(c) A 'diamond ring' seen after a total solar eclipse, just when the Moon starts to move away

Fig. 12.14: Solar eclipse

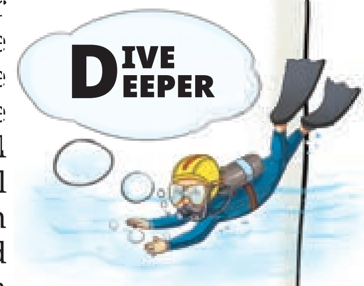
Safe Viewing of a Solar Eclipse

Caution—During a solar eclipse, one might be tempted to look at the Sun, thinking that it wouldn't be strong enough to cause harm to our eyes. However, even during the eclipse, the Sun is intense enough to damage the eyes and cause blindness. Thus, directly viewing solar eclipse must be strictly avoided. Also, do not view it through sunglasses, binoculars, or telescopes.

Usually, astronomy organisations, such as planetaria and astronomy clubs hold eclipse viewing events during a solar eclipse (Fig. 12.15).

Participating in such events is the best way to observe a solar eclipse since the organisers not only provide specialised eye protection for solar viewing, but also offer scientific explanations.

Fig. 12.15: A public solar eclipse viewing organised in Ooty, Tamil Nadu



This activity, similar to Activity 11.5, is to be set up by your teacher. A mirror can be used to project an image of the Sun onto a wall. However, holding it at the correct angle throughout a solar eclipse can be difficult. To solve this, make a movable stand for the mirror. Use a hollow ball with a small hole, half-fill it with sand (to keep it stable), and attach a small mirror (such as an embroidery mirror) to it. Place the ball on a circular ring, like an adhesive tape ring, so it can be turned around easily. Adjust it until the Sun's image appears on a wall or screen. Fig. 12.15 shows this set-up where the mirror is fixed to a green ball.

Caution—This activity should be performed strictly under supervision of a teacher. Take care not to direct the reflected light beam in anyone's eyes.

People have observed eclipses and maintained records since ancient times. When the reasons for eclipses were not known, they feared the occurrence of eclipses. As you can imagine, something blocking the Sun, the main source of heat and light on the Earth, even for a brief period of time, would have been extremely concerning. Many superstitions were attached to solar eclipses in various parts of the world related to the activities that could not be carried out during eclipses—such as eating, cooking, or going out of home. But now that we know the reason why a solar eclipse occurs, we need not fear these events as long as we do not look at the Sun directly. In fact, scientists go around the world to observe the eclipses from wherever these are observable. The eclipses provide them an opportunity to study phenomena that cannot be observed otherwise.

Fascinating Facts

An eclipse is known as *grahan* in Sanskrit and in many Indian languages. Many ancient Indian astronomical texts provide calculations to predict eclipses. The best known and most referred text is the *Surya Siddhanta*, which is written in the classical Sanskrit poetry tradition in rhythmic shlokas.

12.3.2 Lunar eclipse

As the Moon revolves around the Earth, sometimes the Earth can block the sunlight from reaching the Moon. This is known as a **lunar eclipse**. On such days, we see the Earth's shadow falling on the full disc of the Moon. Fig. 12.16 shows the arrangement of the Sun, the Earth, and the Moon during a lunar eclipse.

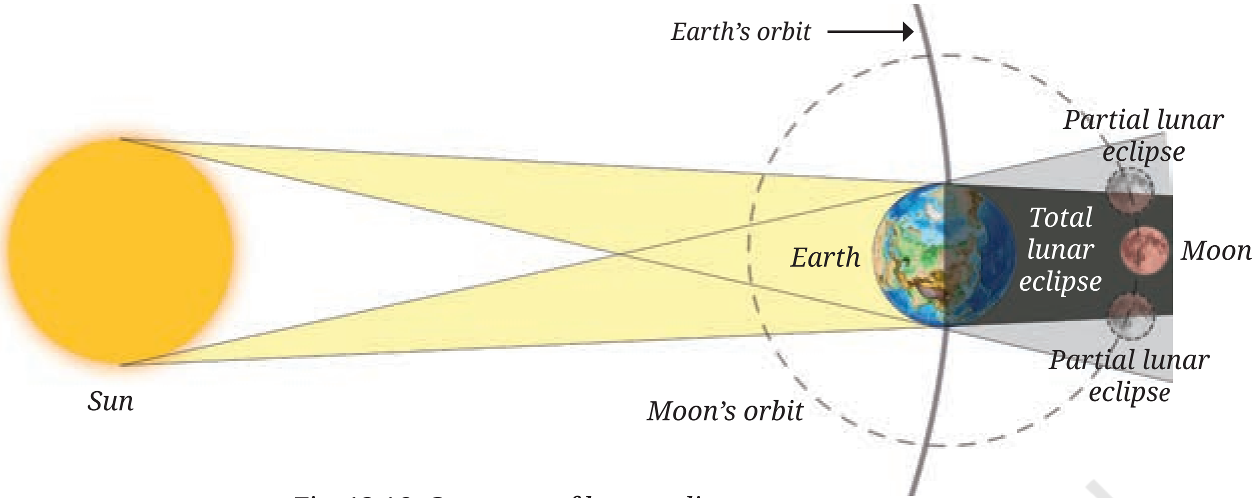


Fig. 12.16: Geometry of lunar eclipse
(The sizes and distances are not to scale in the figure)

When the Moon is completely in the Earth's shadow, it is called a **total lunar eclipse**. The bright disc of the Moon starts to appear dark red in colour and stays that way until the Moon moves out of the shadow of the Earth. When part of the Moon is in the Earth's shadow and the rest of the Moon is visible, it is called a **partial lunar eclipse**. Unlike the Sun, we can safely watch the eclipsed full Moon with our naked eye.

Science and Society

Using the computer version of Stellarium app, which is free, you may get information about the upcoming solar and lunar eclipses (if any) which may be visible from your location.

Fascinating Facts

The Kodaikanal Solar Observatory is located in the beautiful Palani range of hills in southern India. It was established in 1899 and has provided data about the Sun for over 100 years. It is operated by the Indian Institute of Astrophysics (IIA), Bengaluru.

Know a Scientist

M.K. Vainu Bappu is known as the father of modern Indian astronomy. He led efforts in setting up many instruments and telescopes in India, such as the telescopes at Manora Peak near Nainital (Uttarakhand) and Kavalur (Tamil Nadu). The observatory at Kavalur has been named after him. He mainly studied stars and even discovered a comet. He also travelled to different parts of the world to study solar eclipses.

In a Nutshell

- ❖ The Earth rotates on its own axis in about 24 hours.
- ❖ The Earth's rotation from West to East causes day and night as well as the apparent motion of the Sun, the Moon, and the stars.
- ❖ The Earth revolves around the Sun and takes nearly 1 year to complete a revolution.
- ❖ The Earth's axis of rotation is not upright with respect to the orbit, but is tilted.
- ❖ Seasons occur because of the tilt of the Earth's axis of rotation and its spherical shape.
- ❖ A solar eclipse occurs when the Moon is in the path of the Sun as seen from the Earth, and sunlight is blocked from reaching the Earth.
- ❖ A lunar eclipse occurs when the Earth comes in between the Sun and the Moon, blocking sunlight from reaching the Moon.

Let Us Enhance Our Learning

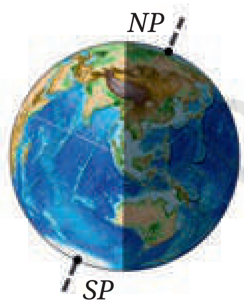


Fig. 12.17

1. In Fig. 12.17, how many hours of sunlight do the North Pole and the South Pole receive during one rotation of the Earth?
2. Fill in the blanks
   (i) Stars rise in the ________ and set in the __________.
   (ii) Day and night are caused by the Earth's _______________.
   (iii) When the Moon fully covers the Sun from our view, it is called a ____________ solar eclipse.

3. State whether True or False
   (i) Lunar eclipse occurs when the Sun comes between the Earth and the Moon.
   (ii) Sunrise happens earlier in Gujarat than in Jharkhand.
   (iii) In Chennai, the longest day occurs on the summer solstice.
   (iv) We should watch the solar eclipse directly with our naked eye.
   (v) Seasons occur due to the tilt of Earth's axis of rotation and its spherical shape.
   (vi) The Earth's revolution around the Sun causes day and night.
4. Padmashree saw the Orion constellation nearly overhead at 8 pm yesterday. When will she see Orion overhead today?
5. Nandhini saw a group of stars rising at midnight on 21 June. When will she see the same group of stars rising at midnight next year?
6. Abhay noticed that when it was daytime in India, his uncle who was in the USA was generally sleeping as it was night-time there. What is the reason behind this difference?
7. Four friends used the following ways to see the solar eclipse. Who among them was being careless?
   (i) Ravikiran used a solar eclipse goggle.
   (ii) Jyothi used a mirror to project the Sun's image.
   (iii) Adithya saw the Sun directly with his eyes.
   (iv) Aruna attended a programme arranged by a planetarium.
8. Fill in the circles in Fig. 12.18 appropriately with one of the following: Sun, Moon, Earth.

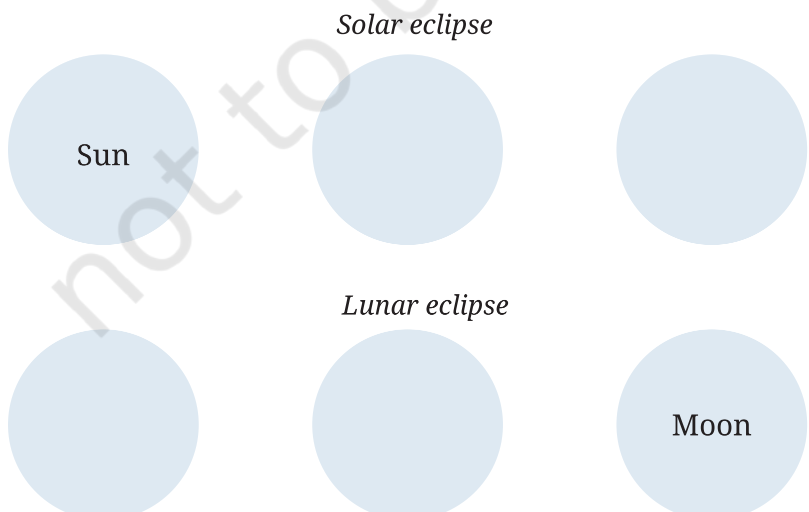
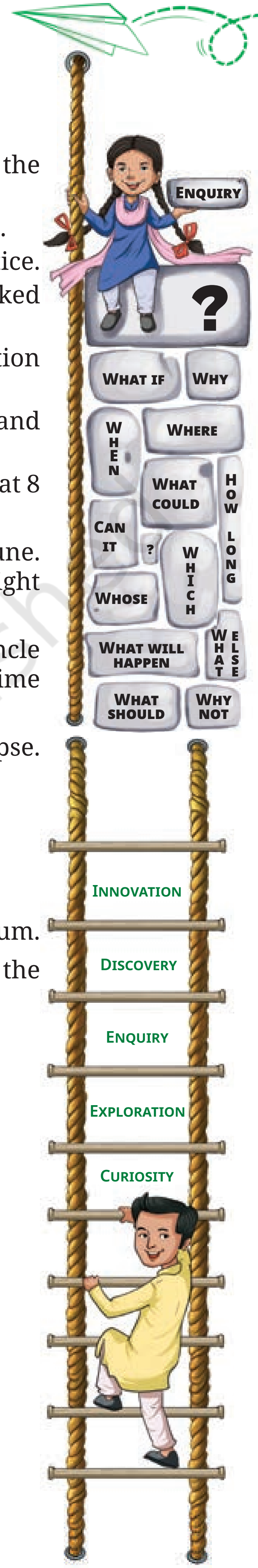
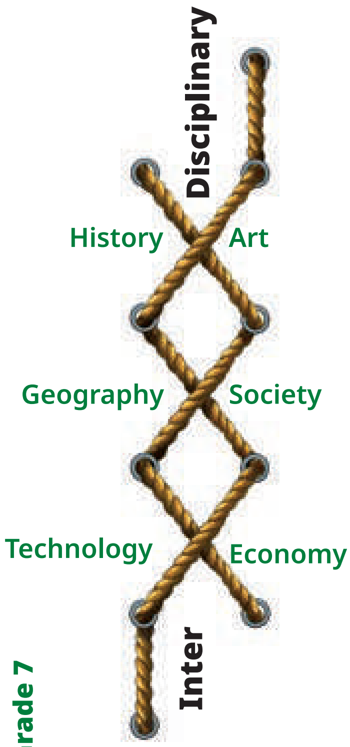


Fig. 12.18



9. The Moon is much smaller than the Sun, yet it can block the Sun completely from our view during a total solar eclipse. Why is it possible?
10. The Indian cricket team matches in Australia are often held in December. Should they pack winter or summer clothes for their trip?
11. Why do you think lunar eclipses can be seen from a large part of the Earth when they happen, but total solar eclipse can be seen by only a small part of the Earth?
12. If the Earth's axis were not tilted with respect to the axis of revolution, explain what would be the effect on seasons?

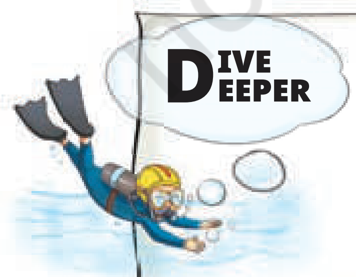


Exploratory Projects

❖ Repeat Activity 12.2 but replace the torch with an electric lamp. Then place the globe at different positions on a circle around the lamp while maintaining the tilt of the globe.
   (i) Note down your observations regarding how much of the Northern and Southern hemispheres of the globe are illuminated at different positions.
   (ii) Rotate the globe and take a note of the length of the day and night on different parts of the globe.
   (iii) Repeat (ii) for different positions of globe on the circle.

❖ The Earth goes around the Sun in an oval-shaped path. Draw two circles with the same centre, one with a radius of 14.7 cm, and another one with a radius of 15.2 cm. If 1 cm corresponds to 10 million km, the two circles represent the closest and farthest distances from the Sun. Note how small is the difference between these two distances.

❖ Suppose the tilt of the Earth's axis of rotation increases. Will it cause more extreme seasons? Find out if the tilt of Uranus is more than the Earth and about the seasons there. Write an interesting article for a newspaper or your school magazine about it.



In reality, the planets move around a special point in the solar system, which is very close to the Sun but not exactly at its centre! The Sun also moves around the same point a little instead of staying perfectly still. Scientists use such tiny wobbles in the movement of other stars to discover exoplanets around them!

It's Still Not the End, My Friend!

And once again, we've reached the last page of this book, and as we said earlier, it is certainly not the end of our curiosity—our *jigyasa*. We hope you've enjoyed the activities and experiments as you journeyed through the chapters. More importantly, we hope you asked a lot of questions! Now it is our time to ask you one.

Have you looked closely at the front and back covers of this science textbook? At first, they may just look like regular scenes from a playground or a running track, but if you observe carefully, you'll find tiny hidden science clues connected to different chapters in the book! Take a closer look—maybe you will spot something related to what we discussed about motion or light, or maybe even about plants and animals?

Challenge yourself to find as many science links with the chapters as you can (we think there are more than 25!). And who knows—you might find connections that the authors and illustrators hadn't even thought about! That is exactly how discoveries in science were made—by someone just observing something new, something unusual in the world around them.

This textbook is just a small guide, a map to find our way around the different paths of science. Never stop asking questions, and remember, your curiosity is the spark that lights the flame of exploration that will take you to incredible heights. And we'll join you again, next year, for more adventures in science.

Notes