2. The Sun, the Moon and the Earth

The moon's motions:

Like the earth, the moon, also has axial and orbital motions. The moon while rotating around itself, revolves around the earth and the earth revolves around the sun. As a result, though the moon does not revolve around the sun independently, indirectly, it makes revolutions around the sun. The time it takes to make one revolution around the earth and one rotation around itself is the same. That is why, we constantly see one and the same side of the moon.

Think about it.

☞ Like sunlight and moonlight, is there anything called the earthlight? If yes, where do you think it is found?

Try this.

Carry out this activity on a playground.

- Select three students.
- Give them the roles of the sun, the moon and the earth.
- Make the sun stand in the middle. (See the title page.)
- Draw an elliptical orbit around the sun.
- The student who has been given the role of the earth should rotate around himself from west to east. Simultaneously he should revolve around the student who is the sun along the drawn orbit in the anti-clockwise direction.
- Make sure that the student who is performing the role of the moon is also revolving around the one who is acting as the earth.
- Draw a diagram of the whole activity in your notebook.

Geographical explanation

The moon's orbit of the revolution is also elliptical as that of the earth. Hence the distance of the moon from the earth is not the same everywhere along its orbit while revolving. When it is the closest to the earth it is said to be in perigee and when it is at the farthest the position is called apogee. See fig. 2.1

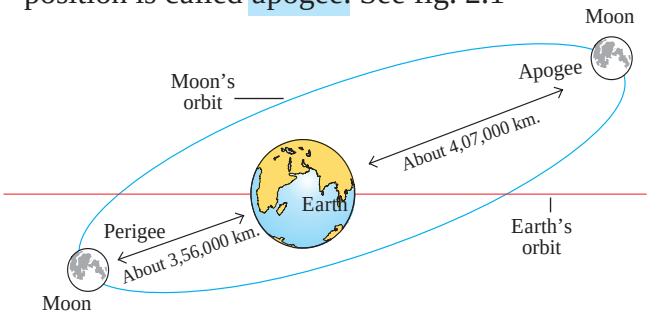


Figure 2.1 : Moon's positions

You have studied the phases of the moon. You know how it waxes from the new moon day to the full moon day and how it wanes from the full moon to the new moon day.

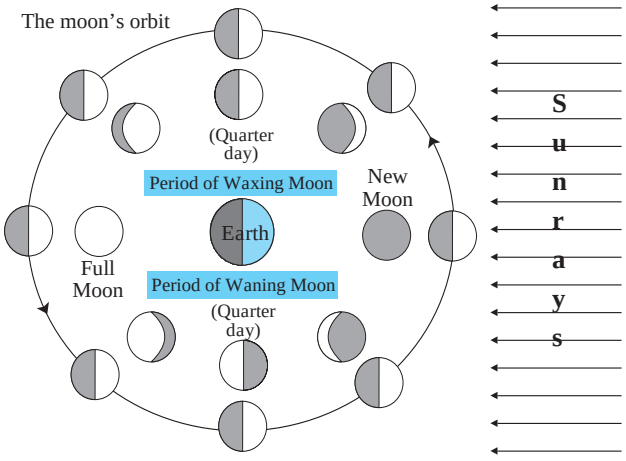


Figure 2.2 : Waxing and waning moon (Phases)

See fig. 2.2 which shows the different phases of the moon. It shows the relative position of the moon on both the quarters, the full moon and the new moon days with respect to the earth and the sun.

Think about it.

☞ Fig. 2.2 shows the positions of the moon as seen from the space and as seen from the earth. How will you identify which are which?

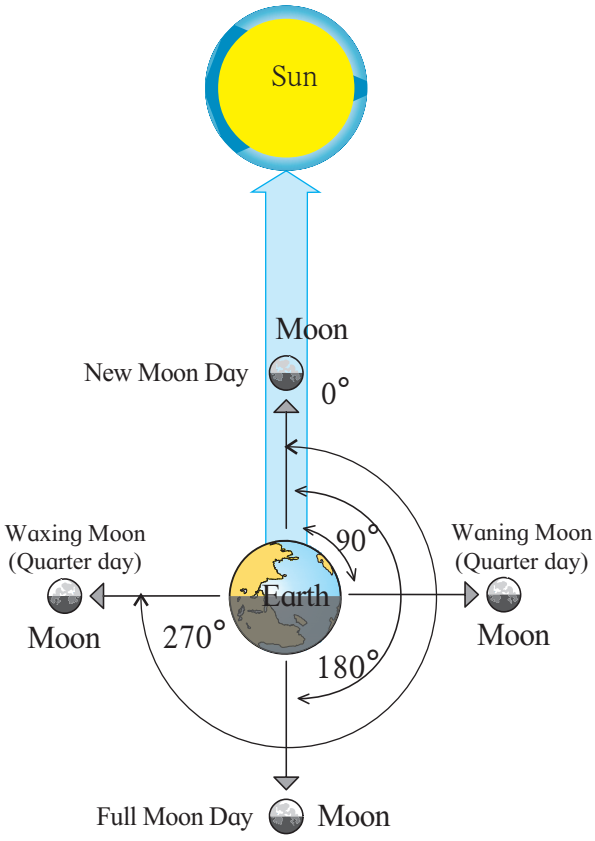


Figure 2.3 : Angles made by the earth-moon-sun

We see the phases of the moon in the sky from the earth. They are the illuminated portions of the moon. They become visible due to the sunlight reflected from the moon. While revolving around the earth, the moon is on the opposite side of the sun on a full moon day, whereas on a new moon day, it is positioned between the sun and the earth. On the first and the third quarter days, the moon, the earth and the sun make an angle of 90°. At these positions, we see half the portion of illuminated moon. Hence in the sky, it appears semicircular in shape. (See fig. 2.3.)

Eclipses:

The orbital path of the earth and that of the moon are not in the same plane. The moon's revolutionary orbit makes an angle of about 5° with that of the earth. As a result, the moon intersects the plane of the earth's orbit twice during one revolution. On each new moon day, the lines joining the earth and the sun and the moon make an angle of 0° whereas on each full moon day, this angle is of 180°. Even so, the sun, the earth and the moon may not be in one straight line in the same plane on every new moon or full moon day. Hence, eclipses do not occur on each new moon or full moon day. (See fig. 2.4.) However, sometimes, on a new moon day or a full moon day, the three fall in one line and are in the same plane. Eclipses occur on such occasions. Eclipses may be solar or lunar.

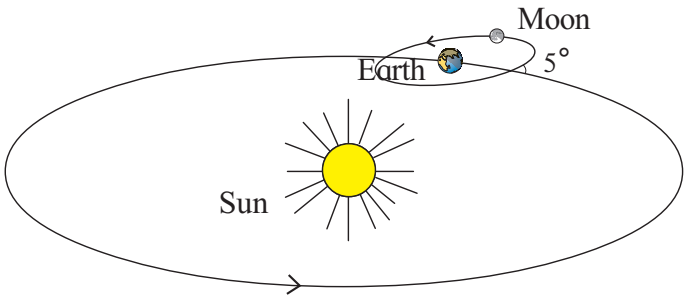


Figure 2.4 : Angle between the planes of orbits

Think about it.

☞ Consider the relative positions of the sun, the moon and the earth on the new moon day and both the quarters. What will be the angle between the lines joining the earth and the moon as well as the earth and the sun? How many times will this angle be formed in a month?

Solar eclipse:

If the moon is between the sun and the earth, the shadow of the moon falls on the earth. At such a time these three celestial objects are on the same plane and fall in one line. Hence the place on the earth where the moon's shadow falls, experiences a solar eclipse. This shadow is of two types. The central portion of the shadow is darker and the periphery is light. In the area of dark shadow on the earth, the sun becomes completely invisible. This condition is known as total solar eclipse. However, during the same period, at the places where the shadow is lighter, the sun disc appears partially covered. This condition is described as partial solar eclipse. (See fig. 2.5) Total solar eclipse is seen in a very limited region of the earth.

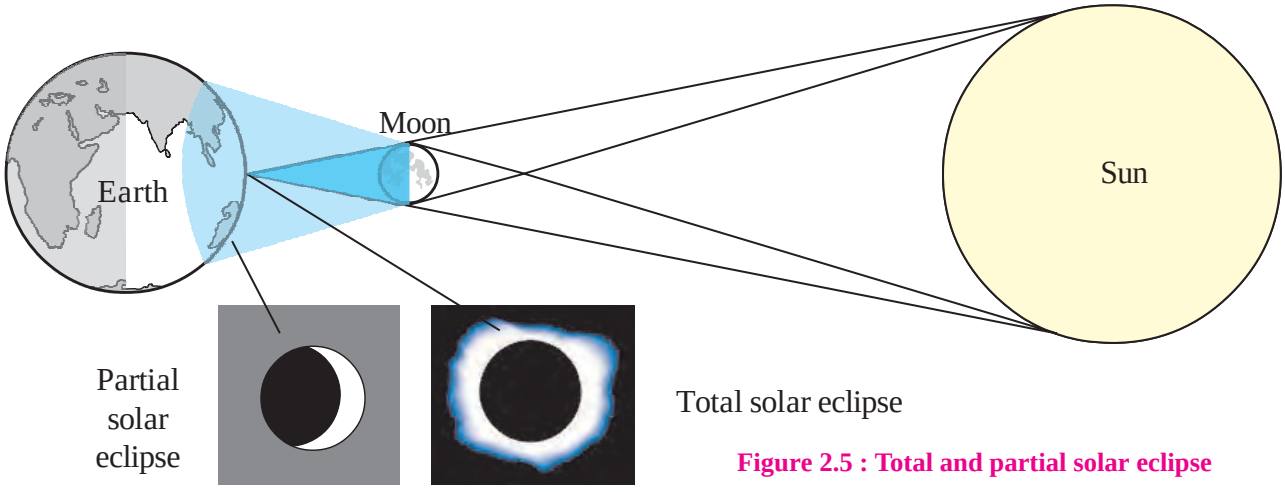


Figure 2.5 : Total and partial solar eclipse

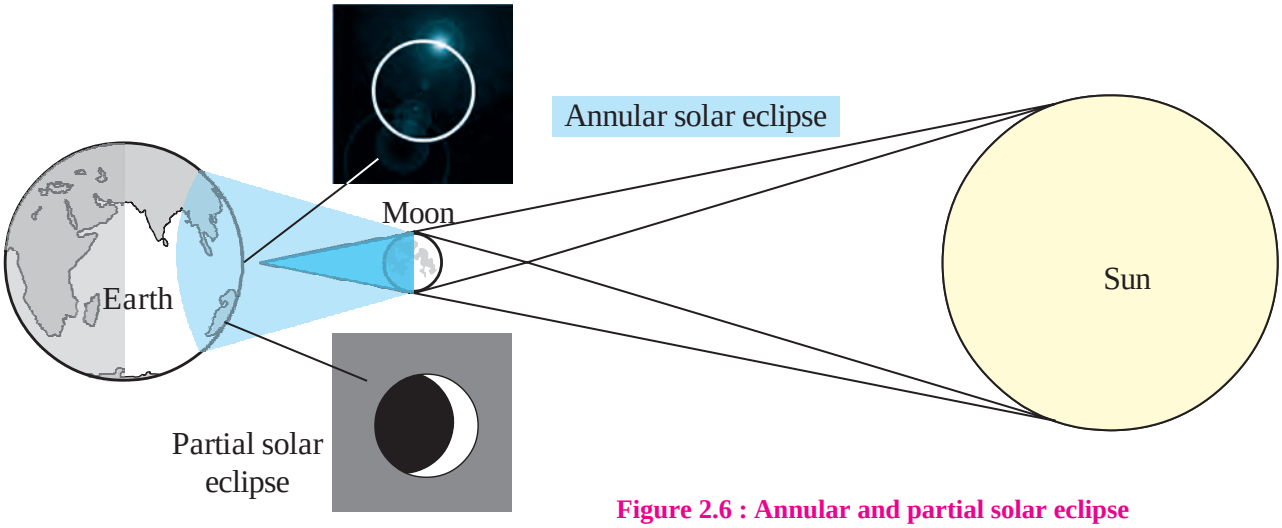


Figure 2.6 : Annular and partial solar eclipse

Sometimes the moon is in apogee position. This means it is at its farthest from the earth. As a result, the deep shadow of the moon is cast in space and does not reach the earth. From a very small region of the earth, only an illuminated edge of the sun disc is seen in the form of a ring. This is called annular eclipse. (Fig. 2.6) Annular eclipse is a rare phenomenon.

Try this.

- Take a ball of clay or mud and keep it at the centre of a table.
- Fix a pencil vertically in the clay ball in such a way that its sharp end points upwards.
- Fix a small plastic or sponge ball on the sharp end of the pencil.
- Draw a circle along the midline of the ball. Let this ball be your moon.
- Now place a large plastic or rubber ball at a distance of 10 to 15 cm. from this moon. Let this larger ball be the earth. Draw a circle

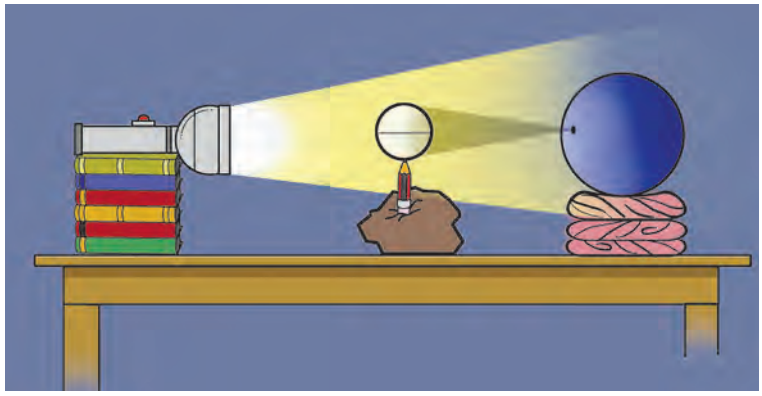


Figure 2.7 : Solar eclipse activity

along the midline of this ball too using a pencil in the centre. Let this be the equator.

- Keep the ball steady using a rubber or cloth ring.
- Arrange the balls representing the earth and the moon in such a way that the circle drawn on the moon will be in the plane of the equator of the earth.
- Take a torch (the sun). Hold it at a distance of about 30 cm from the moon.
- Direct the light beam on the moon. See fig. 2.7.
- Observe the shadow of the smaller ball on the earth to understand how solar eclipse occurs.

Lunar eclipse:

A lunar eclipse occurs when the moon enters the shadow of the earth, while revolving around it. At this time, it is necessary that the earth is between the sun and the moon, and all three of them are in the same plane. On a full moon day, the moon's path of revolution passes through the thick shadow of the earth. If the moon is totally hidden within the shadow, we see a total lunar eclipse and if only a part of the moon is in the shadow, we see a partial lunar eclipse. (See fig. 2.8).

Try this.

- Arrange the materials used for the solar eclipse demonstration earlier, as shown in fig. 2.9 and try to understand how a lunar eclipse occurs.

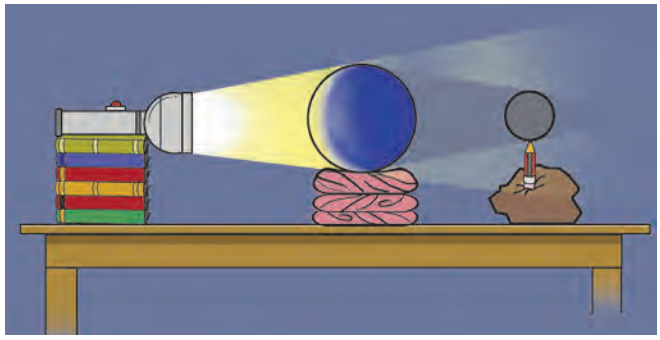


Figure 2.9 : Lunar eclipse activity

Use your brain power!

- On the day of solar eclipse, in which part of the earth will it not be seen?
- Can we see total and annular solar eclipses on the same occasion?
- Why is an annular lunar eclipse not seen?
- Which eclipses will you see from the moon?
- Why are solar eclipses caused by the other planets not seen from the earth?

Think about it.

- When solar eclipses do not occur on a new moon day, does it mean that the moon does not have any shadow at all?

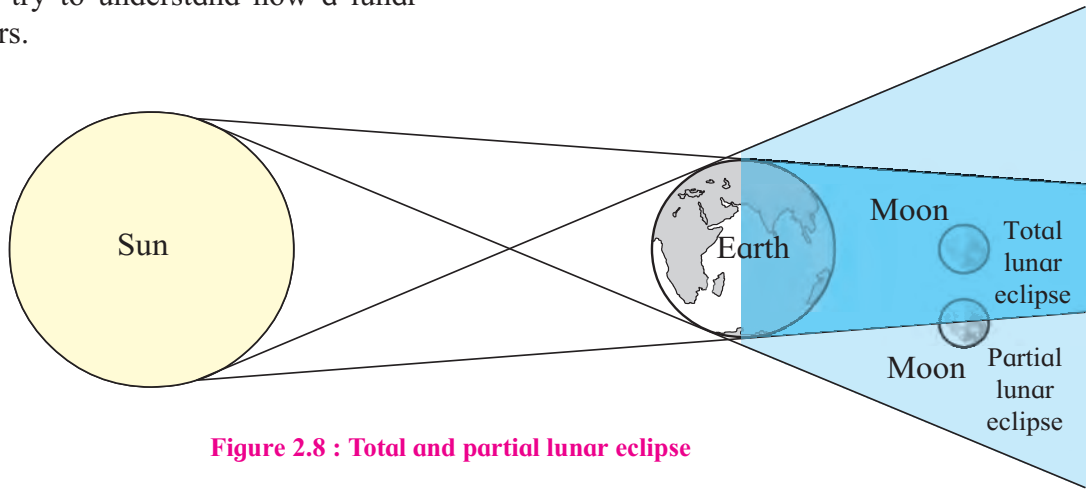


Figure 2.8 : Total and partial lunar eclipse

Characteristics of solar eclipse

- A solar eclipse occurs on a new moon day, but not on every new moon day.
- If and only if the sun, the moon and the earth are in the same plane and fall in one line, the solar eclipses occur.
- The maximum duration of a total solar eclipse is 7 minutes and 20 seconds (440 seconds).

Characteristics of lunar eclipse

- A lunar eclipse occurs on a full moon day, but not on every full moon day.
- A lunar eclipse occurs if and only if the sun, the moon and the earth are in the same plane and fall in one line.
- The maximum duration of a total lunar eclipse is 107 minutes.

Eclipse - an astronomical event:

A solar eclipse or lunar eclipse is just an astronomical event. There is nothing 'auspicious' or 'inauspicious' about these events. It is just a result of the sun, the earth and the moon being in specific positions. There is a lot of curiosity about eclipses, because an eclipse is not a regular occurrence.

For scientists working in the field of astronomy, eclipses and particularly total or annular solar eclipses present great opportunities for study. Scientists from all over the world make it a point to visit the locations where such events are going to occur. They carry out elaborate studies of eclipse conditions.

Always remember –

While observing a solar eclipse, it is necessary to view the sun disc through dark glasses or special goggles made for that purpose, otherwise the intense light of the sun can be harmful to the naked eye.

During the period of a solar eclipse, a large number of birds and animals get confused due to the untimely darkness that sets in. As this is an event that does not suit their biological clock, their response to the event is also unusual. Try to observe the responses of the birds and animals at the time of such events and record your observations.

Do you know ?

Occultation and Transit:

Like eclipses, some other specific conditions occur with reference to the sun or the moon. These are called occultation and transit respectively. Occultation occurs with reference to the moon whereas the transit is associated with the sun.

Occultation: This is a typical event occurring in space. The moon revolves around the earth. While doing so, it obscures a star or a planet and that celestial body appears to hide behind the moon. This is called occultation. The total solar eclipse is actually a kind of occultation. During this, the sun disc gets hidden completely because of the moon.

Transit: If an inner planet like Mercury or Venus comes in between the line of the earth and the sun, a transit occurs. At that time, a small dot appears to move across the sun disc. Transit is a type of solar eclipse.

Figure 2.10 : The transit of mercury

Look for me elsewhere !

- Class 7 General Science Chapter 17
- Class 6 General Science Chapter 16

Exercises

Q. 1. Correct the wrong statements. Write down the corrected ones.

(1) The moon revolves around the sun.

(2) On a full moon day, the moon, the sun and the earth are positioned in this sequence.

(3) The revolutionary orbits of the earth and the moon are in the same plane.

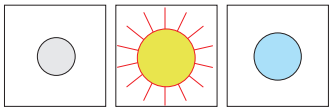
(4) In one revolution of the moon, its orbit intersects the earth's orbit only once.

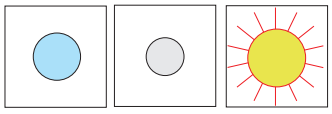
(5) It is alright to observe a solar eclipse without protecting the eyes.

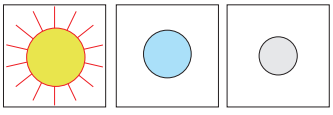
(6) An annular solar eclipse occurs when the moon is in the perigee position.

Q. 2. Select the correct option.

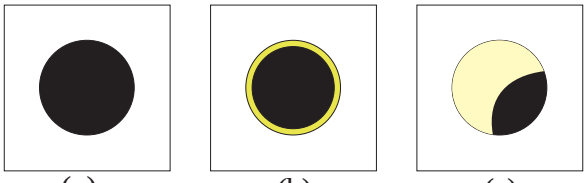
(1) Solar eclipse

(a) 

(b) 

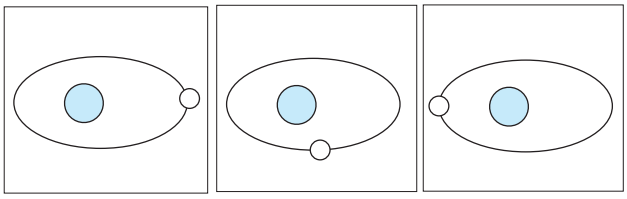
(c) 

(2) The shape of sun disc at the time of annular solar eclipse.



(a) (b) (c)

(3) Apogee position of the moon.



(a) (b) (c)

Q. 3. Complete the following table.

Details	Lunar Eclipse	Solar Eclipse
Phase of the moon		New moon day
Sequence	Moon-Earth-Sun	
Type of eclipse		
Maximum duration of total eclipse	107 minutes	

Q. 4. Draw and label the diagrams.

(1) Total and partial solar eclipse.

(2) Total and partial lunar eclipse.

Q. 5. Answer the following.

(1) Why do the sun, the moon and the earth not lie in one and the same line on every full moon and new moon day?

(2) When total solar eclipse occurs why is partial eclipse also seen from the earth ?

(3) Suggest measures that can be taken to eradicate the superstitions related to the eclipses.

(4) What precautions should we take while observing a solar eclipse ?

(5) What types of solar eclipses will occur in perigee condition ?

Activities:

(1) Collect paper cuttings about eclipses and paste them in a notebook.

(2) Write a note on an eclipse that you have seen.

(3) Using the internet, 'Panchanga' and calendar collect information about the eclipses that are likely to occur this year.

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