Chapter 10

STARS AND THE SOLAR SYSTEM

Observing the night sky is a very fascinating experience for everyone. You might have watched clear blue sky some times and you have observed sunrise and sunset several times. What have you observed in the sky? What do you know about the celestial objects and their movement?

Elderly people seem to know a lot of things. Some of them can tell the time of the day simply by looking at the shadows of some objects. How do they make such guesses?

Read the following questions and check what you know about the sky and our earth.

- What are the celestial objects that we can see in the sky?
- Are the stars moving?
- Do you see the same stars at night and early in the morning?
- Do you see the same stars during summer and winter nights?
- What is the shape of the moon? Why does it change? Why doesn't the sun change its shape daily like the moon?
- Where exactly is the sun situated in the sky at noon?
- Why does the shadow of a tree change from morning to evening?

It is definitely interesting to know answers to the above questions, but it will be more interesting to understand how our ancestors came to an understanding about all these in olden days and what they observed and how they observed the sky and celestial bodies without using instruments like telescopes.

One thing we have to remember, that people made these observations from the earth and not from any other point in the sky. We shall now perform some activities which will help us understand the above questions with some insights.

Activity-1

Observing the changes in the length of shadow

This experiment should be performed on a day when the sky is clear, preferably between nine in the morning and four in the evening.

Pick a spot in the open ground where you can be sure you will have sunlight throughout the day. Also there should not be any trees or buildings nearby which can cast a shadow on this spot during the period of the experiment.

The spot should be as flat as possible. You may find such a spot on your school playground.

Take a stick which is a little over a meter long and fix it vertically in the ground. Ensure that exactly one meter of the stick remains above the surface of ground. You could even build a fence around your stick as shown in figure-1 to keep people away from it.

Fig-1: Changes in lengths of shadow

Make your first observation at nine in the morning. Make a mark with a nail or peg at the point where the tip of the shadow falls on ground. Measure the length of the shadow.

Then, make similar observations for every half an hour throughout the day till four in the evening.

Use a Clock to fix the time for making your observations. Enter the measurements of the length of the shadow and the time of measurement in a table making two columns, one for time and another for length of shadow.

(Since you will be making observations over the next two weeks at least, you should ensure that the pegs and stick are not disturbed.)

- Look at your table and figure out the time of the day of shortest shadow.
- When did you observe the longest shadow in your activity?
- How does the length of the shadow change with time? Illustrate your answer with the help of some diagrams. Draw the diagrams of the stick and its shadow for 5 different times, that is, at 9am, 11am, 12noon, 2pm, and 4pm.
- If you continue your activity from sunrise to sunset, at what times do you think the shadow would be the longest?
- Where is the sun situated in the sky at noon? Where does the shadow of stick fall at that time? Think about how your own shadow will be at that time.
- Do you think that your shadow will be the same on all the days at noon?
- In which direction does the shortest shadow of the stick fall in your activity?

The shortest shadow cast by a vertical object on the ground always falls in the north–south direction. You can use this fact to locate directions. The time when the shortest shadow occurs is called the local noon time at that place

Think and Discuss

Look at the nails or pegs you have fixed on the ground to keep track of the shadow of the stick throughout the day. From their positions, can you tell how the position of the sun changes in the sky from sunrise to sunset?

Continue your observations

Observe on the next day whether the shadow of the stick falls at the same spots at the same times throughout the day.

Can you use your stick as a clock (sun dial) to tell the time? If your answer is 'yes', explain how this is possible.

Two weeks later, once again check to see whether the stick's shadow falls at the same spots at the same times during the day.

- If the shadow does not fall on the same spot, what could be the possible reason?

You observed in activity 1 that the position of the sun in the sky changes during the day. If you continue your experiment for a full year, you will find that the position of the sun changes from day to day as well.

That is, the position of the sun at 10.00 am today will be different from its position two weeks later at the same time. If you choose a particular time every week and mark the position of the sun with a peg at that time, you can build a calendar for the full year. You could use this calendar for the following year to figure out dates.

In olden days people used to calculate the time by observing the shadows of different objects.

- During a period of two weeks you had made an observation that the length of the shadow at a particular time is changing day by day. Did it become longer or shorter?
- By observing the direction of shadows, can you guess the arrival of summer or winter?

Does the sun rise at the same spot throughout the year? Let us do an activity to understand this.

Activity-2

Understanding the North – South movement of the sun.

Fix a spot near your home from where you can observe the sunrise. You may have to go to the terrace of a RCC building or go to an open field for the purpose. Choose a tree, electric pole or some other stationary object as a reference point. Over the next 10 to 15 days, note the spot at which the sun rises daily, keeping in mind your reference point. Make a daily sketch of the rising sun as well as your reference point in your note book during this period. (See figure-2).

Fig-2 : Observing the position of sun

- Does the spot of sunrise change? If it does, in which direction does it seem to move?

When the sun looks like traveling towards south of the sky, it is called the **dakshinayanam**. When it looks like traveling towards north of the sky it is called the **uttarayanam**. (Ask you parents to know about Uttarayanam and Dakshnayanam)

- Was the sun traveling towards south or north during the time you made your observations?
- Do you think that is the reason for the

change in the length of the shadow of the stick day by day in activity 1?

- Assuming that you did not have any calendar and knowledge of months and seasons, can you use movement of the sun to predict the arrival of winter or summer?

Think and Discuss

Why does the sun appears to travel towards north or south? Try to find the answer by reading your social studies chapter **"Earth movements and seasons"** along with this lesson.

Collect the information **:** Are the timings of rising and setting of the sun same every day? Collect the information from news papers for at least a period of a fortnight. Think why the lengths of day and night are different every day. Try to get answers through internet or from other books or from teachers.

Activity 1 can be used to make a **sundial** (a clock based on shadows of an object due to sunlight). But the length of the shadow of our stick is changing day to day because of the north – south movement of the sun which is a problem in making a sundial.

People in olden days overcame this problem and made sundials also. How can we make our own sundial?

Do you know?

There is only one Sundial in our state which is situated in the premises of Satyanarayana Swamy Temple in Annavarayam, East Godavari Dist.

Activity -3

Make your own sun-dial

First of all, you will need to cut a right-angled triangle ABC from a sheet of cardboard. Angle C of the triangle should equal to the latitude of your city or town and angle A should be 90 degrees, as shown in figure 3.

A list of latitudes of districts of Andhra Pradesh is given below in table 1.

Table -1

Sl.No.	Districts	Latitude in Degree North (rounded to whole number)
1.	Chittoor	13
2.	Nellore, YSR Kadapa, Anantapur	14
3.	Prakasam, Kurnool, Guntur	15
4.	West Godavari, Krishna, Mahabubnagar	16
5.	East Godavari, Visakha, Ranga Reddy, Hyderabad, Khammam, Nalgonda	17
6.	Srikakulam, Vizianagaram, Medak, Nizamabad, Karimnagar, Warangal	18
7.	Adilabad	19

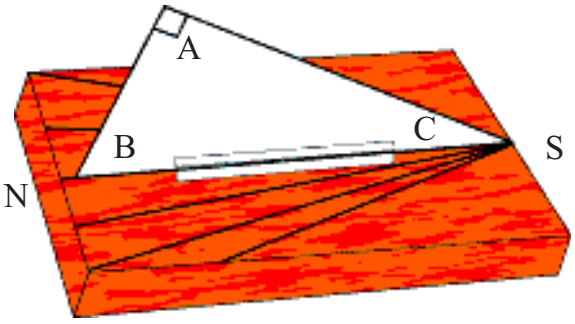


Fig-3 Sun dial

Fix your cardboard triangle vertically in the middle of a rectangular wooden board. Glue strips of paper along both edges of BC and the wooden board to make the triangle stand erect.

Place your board with the triangle on level ground in an open space which gets sunlight throughout the day. Base BC of the triangle should be placed in the north-south direction, with B pointing to the north.

At nine in the morning, draw a line along the shadow of side AC on the wooden board. Write the time alongside the line. Draw lines of the shadow of side AC at one-hour intervals (use a clock to check the time) through the day till sunset and mark the time for each line. Your sun-dial is ready.

You can tell the time by looking at the shadow on the sun-dial. But remember that base BC of the triangle in the sun-dial must always be in the north-south direction if you wish to read the time correctly.

(You can find out the north-south direction at a place by using a stick like in Activity 1, but don't use magnetic compass.)

Now we will try to know a few things about the moon.

- Have you ever observed the movement of moon in the sky?
- Does the moon appear at same point at a particular time every day?
- Is the shape of the moon same on every day?

To understand these issues, let us do some activities. (You can do these activities on your own at home.)

Activity-4

Observing phases of the moon

1. Note the date of the day after new moon day (amavasya), when the moon first appears in the sky.

Also note the time at night when the moon sets (goes down in the western sky). In the same way every day locate the moon in the sky at the time of sunset or immediately after sunset.

Record the date and time of the moon set and draw a picture of the moon as you see it on that day in your note book as shown in figure 4.

Fig-4:Drawing the phases of the Moon

Continue making observations for as many nights as possible.

2. Observe the moon a few days before full moon day (pournami) to a few days after it. Locate the position of moon in the sky at the time of sunset before pournami and note the time and position of moon in the sky at that time.

After pournami, note the time at which the moon rises (comes in the eastern sky) and also note the date. Draw pictures of the shape of the moon on each of these days.

What do you understand from these observations?

- Can you calculate the number of hours between one moon rise and the next moon rise or the number of hours between one moon setting and the next moon setting, with help of these observations?
- How many hours lapse between one sunrise to the next, or one sunset to the next?
- Is the time period same for sun and moon to appear at selected position after completing a cycle in the sky every day?
- Does the moon appear at the same point every day during the time of the sunset?
- What is the shape of the moon? Is it same every day?

You might have observed that the shape of the moon changes night after night. These changes in its appearance are called the phases of the moon. Can you guess why the shape of the moon changes?

You may have noticed that the time period taken by sun to complete a cycle in the sky and come to selected position is almost same every day and it is about 24 hours i.e. 1 day. Whereas moon takes about 50 minutes more than a day to complete the cycle and which results in the phases of the moon.

Let us perform two activities to understand why the phases of moon.occur.

Activity-5

A Moon-shaped lemon

Choose a day one week after the new moon day when the moon is visible in the sky during the day time.

Take a yellow lemon or a whitewashed clay ball and pivot it on a long needle or on a spoke of bicycle. Hold it up towards the moon as shown in figure 5.

Fig-5 : Observing the shape formed by sun light on a lemon

Ensure that you are standing in the sunshine when you do this activity.

Observe the shape formed by the sunlight on the surface of the lemon.

Is there some similarity between the shape formed and the shape of the moon?

Activity-6

Why does the shape of the moon change?

(Do this activity around 4p.m.)

Wrap a ball tightly with a white handkerchief or with a piece of white cloth. Assume this is the moon. Hold this ball in front of your eyes in bright sunshine as shown in figure 6 and turn around yourself slowly. Observe how the shape of the illuminated part of the ball changes.

- Does sunlight fall on half the ball at all times while you turn around?

Fig-6

- Does the shape of the illuminated part on the ball viewed by you same in all positions during your rotation?
- Why does this happen?

To understand the reason better, look at figure7 carefully.

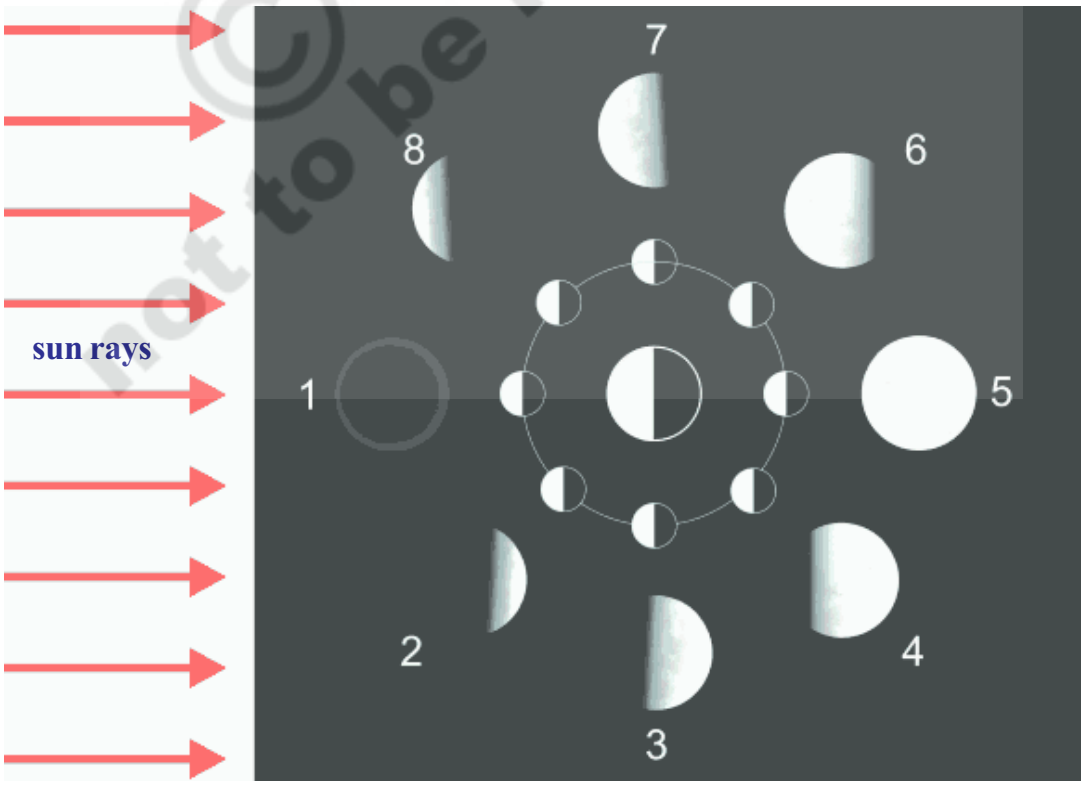


Fig-7 : Phases of moon

The large circle in the middle of figure7 is the earth and the smaller circles around it represent the moon in different positions. You can also see the phases of the moon on different days in the figure. The sunrays falling on the moon illuminate half its surface in all the positions. However, we cannot see the entire illuminated surface from the earth in all the positions. In some cases we see the entire illuminated surface while in others we see only part of it. In one particular position, we cannot see the illuminated surface at all.

The shape of the moon we see is the shape of the illuminated portion visible to us.

In figure 7, the day of the new moon is called day 0 or day 28 (position 1). In this position, the illuminated surface is not visible from earth, so the moon cannot be seen from earth.

Four days later, when the moon is in position 2, a small part of its illuminated surface is visible from earth. On day-7, the moon is in position 3, so more of its illuminated part is visible from earth.

After fourteen days (at position 5) the entire illuminated surface of the moon is visible from earth. This is the day of the full moon.

Subsequently, the moon appears smaller with each day as it passes through positions 6 (day-18), 7(day-21) and 8(day-25). After 28 days, the moon is once again in position 1.

Try to duplicate position 1 with the ball. For this, you will have to hold the ball towards the sun (between your eyesight and the sun).

- In this position, which half of the ball is illuminated?

Although half the surface of the moon is illuminated everyday, we cannot see the moon on new moon day since the illuminated surface is on the side opposite to the point of observation on the earth. On a full moon day, the situation is reversed. The illuminated half of the moon faces the point of observation, so we see a full moon.

From the above explanation, you may have understood that the sun and moon must be on the same side of the earth on a new moon day and they are on opposite sides of the earth on a full moon day.

During the phases in between, we see different shapes of the moon.

Hold the ball in different positions and draw pictures of the shapes of the visible illuminated portion in each case.

The different shapes of the moon in its different phases, as seen from the earth, are shown in figure 7. Compare the drawings you have made with those in figure 7.

- Can you now state as to in which direction the moon will rise on a full moon day?

While we observe moon in clear sky on a full moon day, we think about the spots those are visible on the moon. In olden days also people were curious about those spots on the moon. They did not know the nature of the surface of moon as we know it today. This led to creation of a lot of stories and myths about the spots on the moon.

- Do you know any such stories?

But today we have many satellites that observe the surface of the moon. Human beings landed on the moon way back in 1969. We have better information about moon's surface than our ancestors.

The surface of the moon

When astronauts landed on the moon, they found that the moon's surface is dusty and barren. There are many craters of different sizes. It also has a large number of steep and high mountains. Some of these are as high as the highest mountains on the earth. But the moon has no atmosphere like that on the earth.

- Will we be able to hear any sound if we were on the moon? Why?
- Can any life exist on the moon? Why?

Do you know?

Our country launched Chandrayan-1 (Satellite to Moon) on 22nd October 2008 to know about the moon.

The objectives of Chandrayan-1 are:

1. To check the possibility of finding water on the moon
2. Finding out the elements of matter on moon
3. To search for Helium-3
4. To make 3 dimensional atlas of the moon
5. To study about the evolution of the solar system

Now India is one of the six countries which have sent satellites to the moon. Search the findings of Chandrayan-1 on internet or in news papers.

Think and Discuss

Scientists are planning to build settlements on moon and are trying to make arrangements to live there. You know that there is no air on moon. How will it be possible to live on the moon then?

We feel pleasant during the night of full moon. But sometimes on full moon day the moon loses its brightness for some time, it appears covered – partially or fully. This is called **Lunar eclipse.** Why does the moon get covered? Like the moon, the sun also gets covered partially or fully on some of the new moon days. This is called **Solar eclipse**. Let us try to understand these phenomena.

Solar Eclipse

A solar eclipse occurs when the shadow of the moon falls on the earth. It occurs only on new moon day.

Types of solar eclipse

1. **Total Solar eclipse:** It occurs when the moon completely covers the Sun, as seen from earth.
2. **Partial Solar eclipse:** It can be observed when only the partially shaded outer region of the shadow cast by moon (Lunar penumbra) touches the earth.
3. **Annular eclipse:** It occurs when the moon appears smaller than the sun as it passes centrally across the solar disk and a bright ring, or annulus, of sunlight remains visible during eclipse.

4. **Hybrid eclipses:** These are a rare form of Solar eclipse, which changes from an annular to a total solar eclipse along its path.

Lunar eclipse

A lunar eclipse occurs when the shadow of the earth falls on the moon. It occurs only on full moon day.

Types of lunar eclipse

1. **Total Lunar eclipse:** It occurs when the earth's shadow(Umbra) obscures all of the moon's visible surface.
2. **Partial Lunar eclipse:** It can be observed only when part of the moon's visible surface is obscured by the earth's shadow.
3. **Penumbral Lunar eclipse:** It happens when the moon travels through the partially shaded outer region of the shadow cast by the earth(earth's penumbra).

- Why does a lunar eclipse occur only on a full moon day?
- According to figure-7, in which position can the shadow of the earth fall on the moon?
- Can this position occur only on one particular day?
- Can you now explain why a solar eclipse occurs only on a new moon day?

However, why is it that a solar eclipse does not occur on every new moon day and a lunar eclipse does not occur on every full moon day? Let us try and understand the reason.

A total solar eclipse occurred on the afternoon of **February 16, 1980 (**it was seen in Mahaboobnagar, Nalgonda and Khammam districts and also in some areas of Krishna district in Andhra Pradesh.**)** Because the sun was covered during the eclipse, it looked like night during the day time.

Figure 8 contains a sketch of the time exposure photograph of this eclipse. That means the exposures of the different stages of the eclipse were made at 10-minute intervals on the same frame.

Fig-8

The sketch from left to right shows the moon slowly covering the sun and then moving away. The uncovered portion of the sun appears white and the black circles represent the moon in the sketch.

You can easily guess the position of the moon at each stage of the eclipse. Can you draw lines tracing the paths of the sun and moon in the sketch?

The white portions of the discs in figure8 represents the sun and the black portions represents the moon. Each of these discs depicts the position of the sun and moon at various stages of the eclipse.

Make 2 discs one white and one black of the size of sun and moon as in figure 8.

We shall now find the centers of the sun and moon at each stage. To do this, take the white disc you have made and place it exactly on the white portion of any of the stages in the diagram.

Pierce a hole through the center of your disc with a pin to mark the spot at the center of the sun's position at that stage in the diagram. Remove the white disc and mark the spot with a pencil.

In this way, mark the sun's center at every stage of the eclipse in your diagram. Join these spots with a line. This line depicts the path of the sun.

To find the moon's path, repeat the exercise, but this time use the black disc and mark the centers of the black portions at each stage of the eclipse. Join these spots with a line and you will get the path of the moon during the eclipse.

Do the sun and moon follow parallel paths or do their paths cross each other during the course of the eclipse?

There is another aspect to note in figure8. The sun and moon reached the point of intersection of their paths at exactly the same time during the eclipse on February 16, 1980.

- If this had not happened, would a total solar eclipse still have occurred?
- Can you now tell why a solar eclipse does not occur on every new moon day?

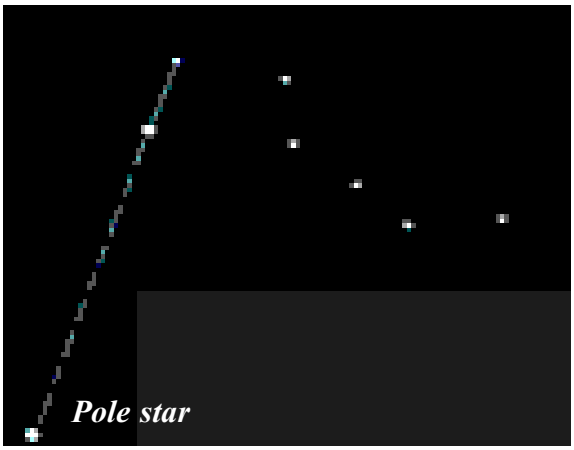
What would be the difference in the position of the sun and moon on new moon days when no eclipse takes place and when there is an eclipse? Use the sketch to try and figure out your answer.

Some other fascinating celestial objects in the sky are stars. They usually appear in groups and members of these groups when viewed together form different shapes. People used to assign some shapes of animals and human being to those small groups. Those groups are called constellations. A group of stars which contains millions of stars are called galaxy. Millions of galaxies together make our universe.

Let us know something about stars

When you look at the night sky, do the stars appear to be moving? If you wish to study the movement of stars across the sky and to trace their paths you must observe the pole star, the seven stars of the saptarishi (great bear) constellation and the six stars of the Sharmistha (Cassiopeia) constellation.

You can easily recognize the great bear with its rectangular head in the northern sky (figure 9a).



Fig–9(a): Great bear constellation (saptarishi) - position of pole star

In winter, this constellation rise a few hours before sunrise (we can see this from anywhere in Andhra Pradesh). In this season, you can also see Cassiopeia in the same part of the sky, its six stars forming the letter 'M' (figure 9b)

Fig-9(b): Casseopia constellation (Sharmistha) - position of pole star

You can locate the pole star (Polaris) with the help of these two constellations. If you are able to spot only the great bear, look at the two stars that form the outer side of its rectangular head. Extend an imaginary line from these two stars. The pole star will be located on that extended line with a distance of about 5 times the distance between these two stars (figure 9a).

If only Cassiopeia is visible, the pole star will be located on a line extended from the middle star of the 'M' (figure 9b).

Once you have located the Great Bear, Cassiopeia and pole star in the night sky, do the following activity.

Activity -7

Observing the movement of constellations (stars)

Take a 20cm x 20cm square sheet of paper and make a 1cm diameter hole in its center. Mark a cross (X) on one side of the sheet of paper as shown in figure 10.

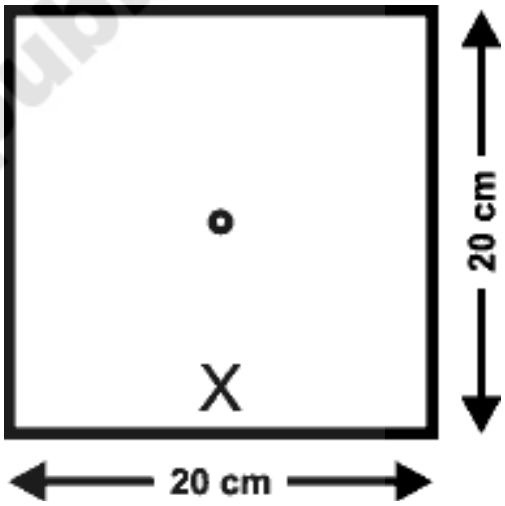


Fig-10

Hold the sheet in front of your eyes with the 'x' mark at the bottom and look for the pole star through the hole. Once you have located the pole star, check in which direction the Great Bear and Cassiopeia lie.

Write 'G' for Great Bear and 'C' for Cassiopeia on the paper in the directions in which you see each of the constellations. Mark the timing at which you made your observation in both cases.

Choose a nearby tree or house as a reference point. Draw a picture of your reference point on the paper sheet taken, clearly indicating its location.

Repeat your observations at one-hour intervals. Ensure that you are standing on the same spot each time you look at the stars.

Write G, C in the direction of the position of the great bear and Cassiopeia during each observation and note the time of the observation next to the letters G and C.

Using the tree or house you have chosen as your reference point, check whether the position of the pole star has changed or not. If it has changed, note the changed position.

Repeat this activity as many times as possible, the minimum being four times. But ensure that the 'x' mark on your sheet of paper remains at the bottom during all your observations.

You could also use other known stars or constellations close to the pole star to perform this activity.

Study the picture you have drawn and answer the following questions.

- Do the positions of the stars change with time?
- Does the position of the pole star also change with time?
- Does the shape of the great bear and Cassiopeia change with time or does the position of the entire constellations in the sky change?
- What kind of path do these constellations trace in the sky?

From your observations, you would have realized that the stars do not remain in the same spot in the sky but revolve around the pole star. The pole star, however, remains fixed at one place. It takes the stars 24 hours to complete a revolution around the pole star. We can observe only half this revolution during the course of a night.

If all stars move, why doesn't the pole star move? Let us try to understand it by doing the following activity.

Activity -8

Why the pole star appears fixed at one point?

Take an umbrella and open it. Make about 10 – 15 stars out of white paper. Paste one star at the position of the central rod of the umbrella and others at different places on the cloth near the end of each spoke (figure 11).

Fig-11

Now rotate the umbrella by holding its central rod in your hand. Observe the stars on the umbrella. Is there any star which does not appear moving? Where is this star located? Is it located where the rod of the umbrella holds the cloth of the umbrella?

On similar lines, if there were a star located where the axis of rotation of the

earth meets the sky, could this star also be stationary?

The pole star is situated in the direction of the earth's axis and that is why it does not appear to move even though all stars appears that they are moving because of the rotation of the earth. (figure 12).

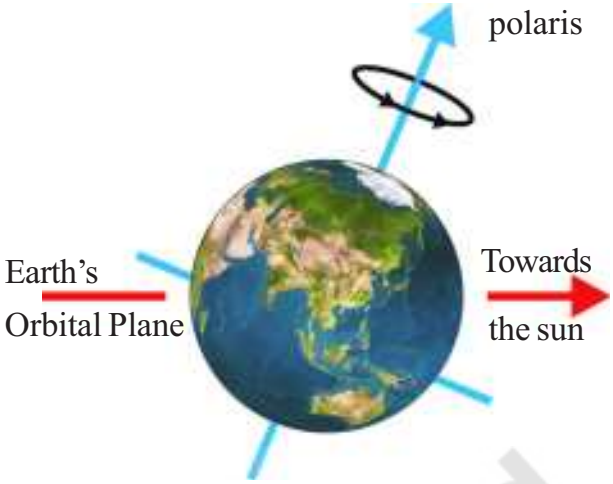


Fig-12:Direction of Pole Star

Some of the constellations visible from Andhra pradesh

Fig-13: Saptha rushi *Sharmista* *Orion* *Leo (Simha Rashi)*

Some of the Galaxies in our Universe

Fig-14

Among millions of galaxies our sun is a star in Milky Way galaxy. Our earth is revolving around the sun. And moon is revolving around the earth. Do you know that not only the earth but also some other celestial bodies are revolving around the sun? Let us know something about those celestial bodies.

The solar system

The sun and the celestial bodies which revolve around it form the solar system. It consists of large number of bodies such as planets, comets, asteroids and meteors. The gravitational attraction between the sun and these objects keeps them revolving around it.

The earth revolves around the sun. It is a member of the solar system. It is a planet. There are seven other planets that revolve around the sun. The eight planets in their order of distance from the sun are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

Figure -15 shows a schematic view of the solar system.(Not to the Scale).

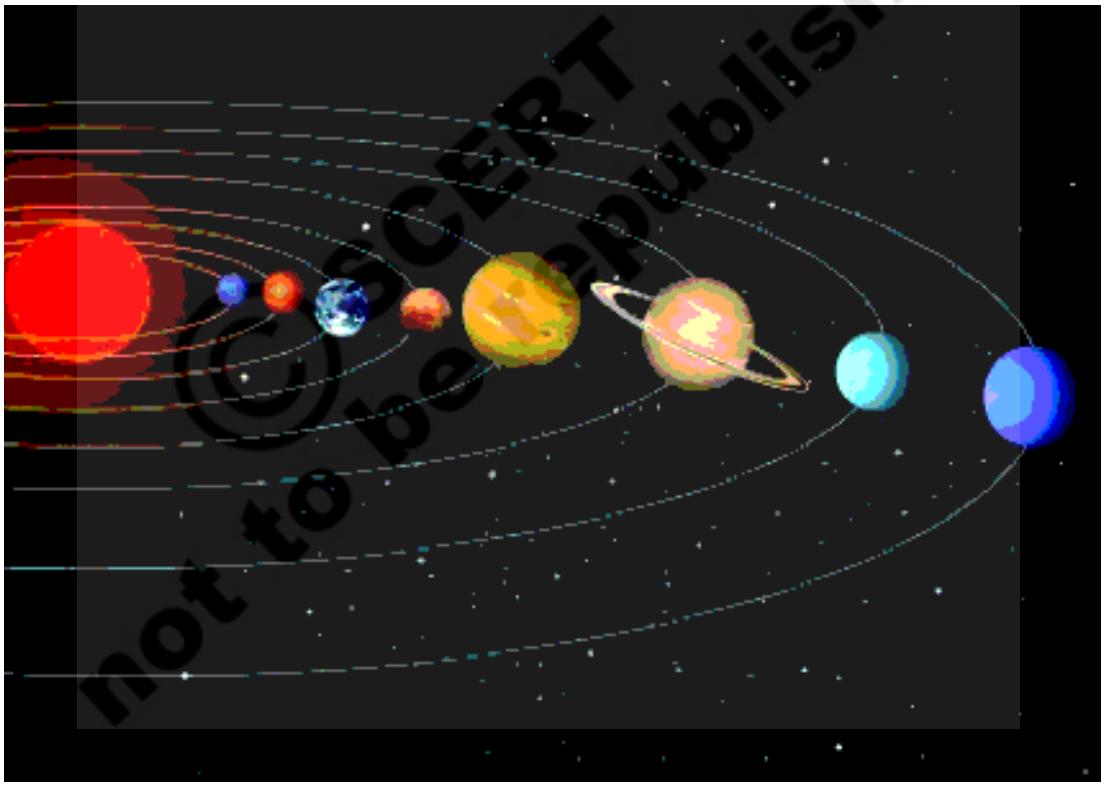
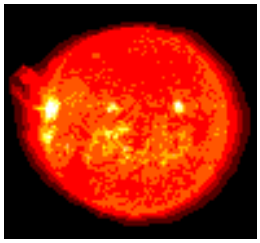


Fig-15

Let us learn about some members of the solar system.

The sun



The sun is the nearest star to us.

It is continuously emitting huge amounts of heat and light and other electromagnatic radiations. The sun is the source of almost all energy on the earth. In fact, the sun is the main source of heat and light for all planets of our solar system.

The planets

The planets look like stars, but they do not have light of their own. They merely reflect the sunlight that falls on them.

A planet has a definite path in which it revolves around the sun. This path is called an **orbit**. The time taken by a planet to complete one revolution is called its **period of revolution**. The period if revolution increases as the distance of the planet from the sun increases.

Besides revolving around the sun, a planet also rotates on its own axis like a top. The time taken by a planet to complete one rotation is called its **period of rotation**.

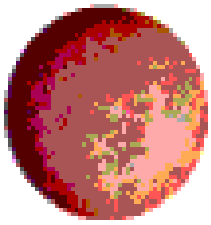
Some planets are known to have moons/satellites revolving round them. Any celestial body revolving around another celestial body is called its **satellite**.

The earth revolves around the sun. Does it make earth a satellite of the sun?

The earth can be said to be a satellite of the sun, though generally we call it a planet of the sun. We use the term satellite for the bodies revolving around planets. Moon is a satellite of the earth. There are many man-made satellites revolving round the earth. These are called **artificial satellites**.

Mercury (budhudu)

The planet mercury is nearest to the sun. It is the **smallest planet** of our solar system.



Because mercury is very close to the sun, it is very difficult to observe it, as most of the time it is hidden in the glare of the sun. However, it can be observed just before sunrise or just after sunset, near the horizon.

So it is visible only at places where trees or buildings do not obstruct the view of the horizon. Mercury has no satellite of its own.

Venus (sukrudu)

Venus is earths nearest planetary neighbour. It is the **brightest planet** in the night sky. Sometimes Venus appears in the eastern sky before sunrise.

Sometimes it appears in the western sky just after sunset. Therefore it is often called **a morning or an evening star,** although it is not a star. Try to locate Venus in the night sky during early winter.

Venus has no satellite of its own. Rotation of Venus on its axis is somewhat unusual. It rotates from east to west while the earth rotates from west to east.

- Does the sun rise in the east on Venus?

If you get a chance, try to observe Venus through a telescope. You will observe that Venus shows phases just like the moon.

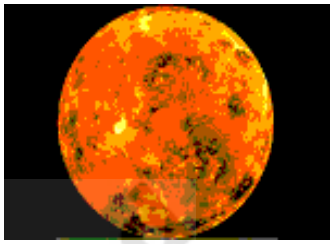
The earth (bhoomi)

The earth is the only planet in the solar system on which life is known to exist.

Some special environmental conditions are responsible for the existence and continuation of life on the earth. These include just the right distance from the sun so that it has the right temperature range, the presence of water and suitable atmosphere and a blanket of ozone. We must take special care to protect our environment so that life on earth is not disturbed.

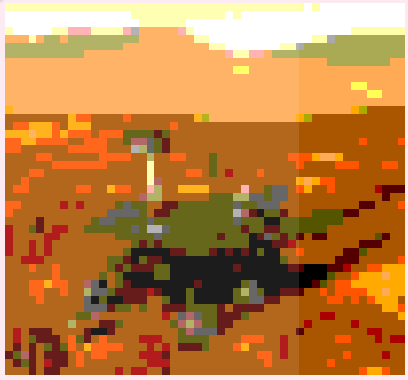
From space, the earth appears blue-green due to the reflection of light from water and landmass on its surface. The earth has only one moon revolving around it.

Mars (kujudu / angarakudu)



The next planet, the first outside the orbit of the earth is mars. It appears slightly reddish and therefore, it is also called the **red planet.** Mars has two small natural satellites.

Mars science laboratory: National Aeronautic and Space Administration (NASA) in America started a mission called 'Mars Science Laboratory' on 26th November 2011, to know more about Mars. A rover named 'Curiosity' landed on Mars on 6th August 2012. It is analyzing the elements in the rocks of the surface of the Mars. It found few indications of water on Mars. It is searching whether the favorable conditions for life exist on Mars.

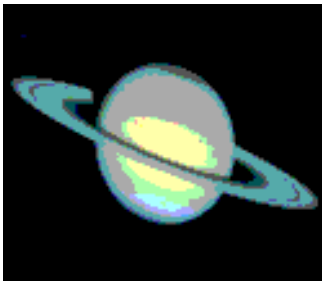


Jupiter (brihaspati)

Jupiter is the **largest planet** of the solar system. It is so large that about 1300 earths can be placed inside this giant planet. However, the mass of Jupiter is about 318 times that of our earth. It rotates very rapidly on its axis. Jupiter has a large number of satellites.

It also has faint rings around, appears quite bright in the sky. If you observe it with the help of a telescope, you can also see four of its large moons.

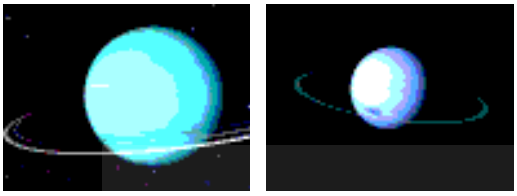
Saturn (shani)



Beyond Jupiter is Saturn which appears **yellowish** in colour. What makes it unique in

the solar system is that it has rings. These rings are not visible to the naked eye. You can observe them with a small telescope. Saturn also has a large number of satellites.

Uranus and Neptune



These are the outermost planets of the solar system. They can be seen only with the help of large telescopes. Like Venus, Uranus also rotates from east to west. The most remarkable feature of Uranus is that it has highly tilted rotational axis (figure 16). As a result, in its orbital motion it appears to roll on its side.

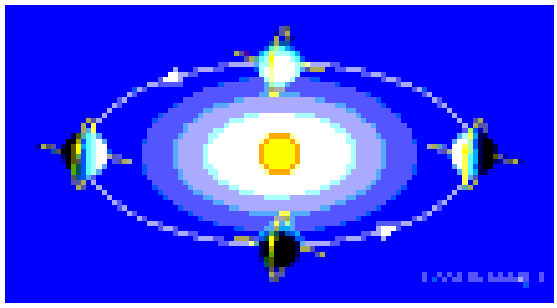


Fig. 16

The first four planets, mercury, venus, earth and mars are much nearer the sun than the other four planets. They are called the inner planets. The inner planets have very few moons.

The planets outside the orbit of Mars, namely Jupiter, Saturn, Uranus and Neptune are much farther away from the sun than the inner planets. They have a ring system around them. The outer planets have a large number of moons.

Table-2 : Comparison between planets

Name of the Planet	Comparative Diameter with Diameter of Earth	Distance from the Sun in Crore km.	Period of revolution	No. of satelites (detected so far)
Mercury	0.38	5.79	88 days	0
Venus	0.95	10.8	225 days	0
Earth	1	15	365 days	1
Mars	0.53	22.8	687 days	2
Jupiter	11.19	77.8	12 years	50
Saturn	9.40	142.7	29.5 years	53
Uranus	4.04	286.9	84 years	27
Neptune	3.88	449.7	165 years	13

We took Earth's diameter (12756 Km) as 1 unit. With this information find the diameters of other planets using the comparison given in table-2.

Think a\nd Discuss

The diameter of the sun is 13,92,000 Km.

The diameter of the earth is 12,756Km.

The diameter of the moon is 3,474 Km.

The distance from the sun to earth is 15,00,00,000 Km.

The distance from the earth to moon is 3,84,399 Km.

Take the scale as 1 lakh km = 1 cm, and imagine how the arrangement of sun, earth and moon is in our universe. Can you make this arrangement on your school-ground?

Do you know?

Till 25th August 2006 we used to say there are nine planets in our solar system. The ninth planet at that time was 'Pluto'. In the 26th general assembly of International Astronomical Union it was decided that 'Pluto' is no more a planet. The decision was taken since it was observed that Pluto does not follow the rule of "cleared the neighborhood". That means sometimes it is entering into the orbit of Neptune.

Some other members of the solar system

There are some other bodies which revolve around the sun. They are also members of the solar system. Let us know about some of them.

Asteroids

There is a large gap in between the orbits of mars and Jupiter (figure-17). This gap is occupied by a large number of small objects that revolve around the sun. These are called asteroids. Asteroids can only be seen through large telescopes.

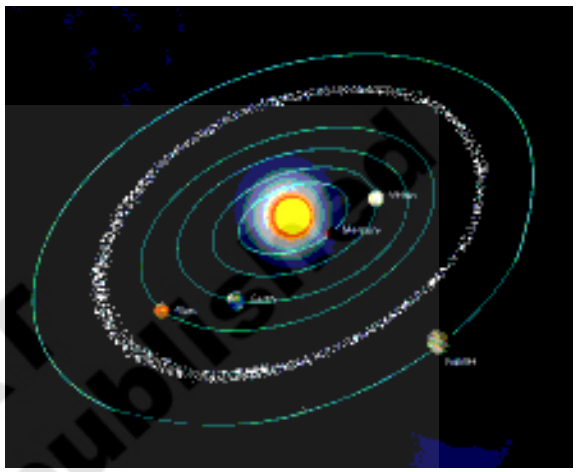


Fig. 17

Comets

Comets are also members of our solar system. They revolve around the sun in highly elliptical orbits. However, their period of revolution round the sun is usually very long. A comet appears generally as a bright head with a long tail. The length of the tail grows in size as it approaches the sun. The tail of a comet is always directed away from the sun (figure 18).

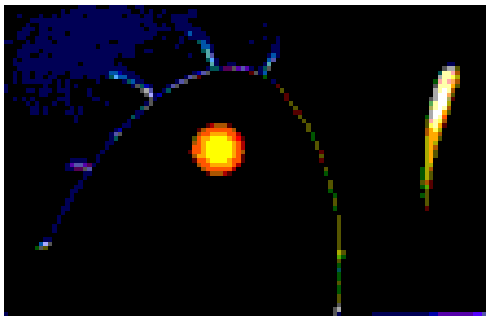


Fig. 18

Many comets are known to appear periodically. One such comet is Halley's comet, which appears after every 76 years. It was last seen in 1986. Can you tell when Halley's comet will be visible again?

Meteors and meteorites

At night, when the sky is clear and the moon is not visible, you may sometimes see bright streaks of light in the sky (fig.19).

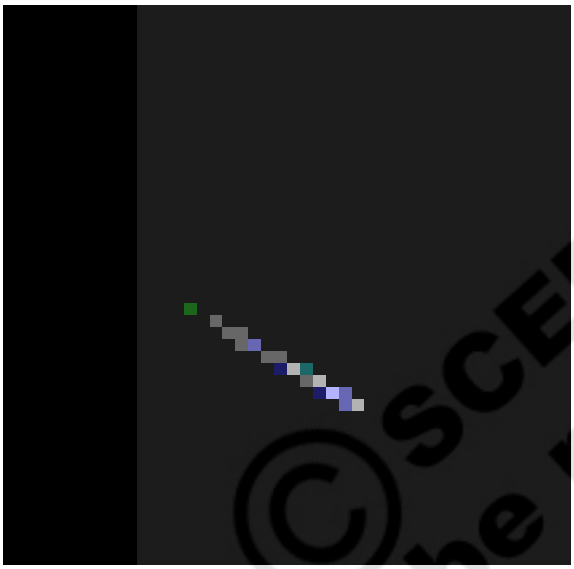


Fig. 19

These are commonly known as shooting stars, although they are not stars. They are called meteors. A meteor is usually a small object that occasionally enters the earth's atmosphere. It has a very high speed. The friction due to the atmosphere heats it up. It glows and evaporates quickly. That is why the bright steak lasts for a very short time. Some meteors are large and so they can reach the earth before they evaporate completely. The body that reaches the earth is called a meteorite (figure-20).

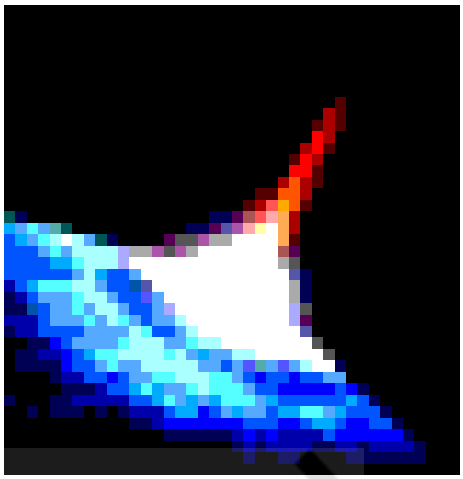


Fig. 20

Meteorites help scientists in investigating the nature of the material from which solar system was formed.

Artificial satellites

You must have heard that there are a number of artificial satellites which are orbiting the earth. Artificial satellites are man-made. They are launched from the earth. They revolve around the earth much closer than earth's natural satellite, the moon.

India has built and launched several artificial satellites. Aryabhatta was the first Indian artificial satellite (figure-21).

Some other Indian satellites are INSAT, IRS, kalpana-1, EDUSAT, etc.

Fig. 21

Artificial satellites have many practical applications. They are used for forecasting weather, transmitting television and radio

signals. They are also used for tele communication, remote sensing (collecting information from a distance) in aviation and military use.

This information about solar system is known to us for the past 2 to 3 hundred years, after the telescopes were made. But how did the people of olden days know so much about the celestial bodies and also about earth?

Let us know about some of the interesting constructions of their knowledge.

How people came to an understanding that earth is spherical?

In olden days people felt that earth is flat because it looks flat. However they had a doubt, if it is flat how does the water in oceans remain there, why does it not spell out of the earth? To get clarity they assumed a fencing around the flat earth. After that

1) They assumed the shape of earth as round by observing the shadow of earth in lunar eclipse. In every eclipse they found the shape of earth is in round even though there is a chance of getting linear, elliptical shadows by a circular object.

2) Some sailors, who started their journey in ocean, reached the same place after traveling large distance in one direction only.

3) Observing ships approaching the port also helped to change their opinion about the shape of the earth, that is, usually they see smoke of the ship first and then the top of the ship after that the whole ship.

4) Observations about the movement of stars. Different stars visible from different places on the earth also helped to think about the shape of the earth.

Through all such observations made by so many people at so many places on the earth they came to an understanding that earth is spherical. And then it is get clarified in 1969 when man landed on the moon and observed the earth's shape from the moon.

How people came to an understanding that earth rotates on its own axis?

People from olden days thought that earth is located in the center of the universe with sun, moon and stars moving around it. They also thought that sun, moon and stars are located on transparent concentric spheres sorrounding the earth, because they are not falling down.

The three spheres are rotating on their axis from east to west that is why sun, moon and stars appear to revolve from east to west around the earth. They also assumed that the sphere on which sun is located rotates east to west and oscillates from south to north that is why uttarayanam and dakshinayanam are happening.

Because of the uneven movement of some stars (actually they are planets) which they observed, it became very difficult to explain the model of universe which required so many transparent spheres around the earth. Nicholas Copernicus suggested that the sun is at the center of the universe and all other celestial objects are revolving around the sun from west to east. It was assumed that earth rotates on its axis. This model could explain the occurence of day and night.

In this way people came to an understanding that earth rotates on its axis.

Key words

Celestial bodies Local noon, Sundial, Dakshinayanam, Uttarayansm, Phases of the moon, Constellation, Galaxy, Pole star, Solar system, Planets, Satellites, Artificial satellites, Asteroids, Comets, Meteors, Meteorite.

What we have learnt

- The shortest shadow cast by a vertical object on the ground always falls in North, South direction.
- The shortest shadow of on object occurs at local noon.
- The time duration for appearance of sun and moon after completion of a cycle is different.
- Changes in appearance of moon are called phases of the moon.
- On the new moon day, sun and moon are on the same side of the earth.
- On the full moon day, sun and moon are on either sides of the earth.
- Moon has no atmosphere like we have on the earth.
- The polestar is situated in the direction of the earth's axis and hence it appears as not moving.
- There are eight planets in our solar system.
- Among eight planets of solar system earth is the only planet which supports life.
- Large number of objects that revolve around the sun between the orbits of Mars and Jupiter are asteroids.
- The length of the tail of the comet grows in size as it approaches the sun.
- A meteor is usually a small object that occasionally enters the earth's atmosphere.
- A body that reaches the earth is called a meteorite.
- Aryabatta was the first Indian artificial satellite.
- Fore casting weather, transmitting Television and Radio signals, Telecommunication, remote sensing are the practical applications of artificial satellites.

Improve your learning

1. How can you find north – south direction at your place? (AS_3)
2. What is your local noon time? (AS_1)
3. In which direction (towards north or south) is the sun moving day by day when you read this lesson? (AS_3)
4. What is the duration of a day and night today? Collect the information about duration of day night for the past 7 days from the news papers, analyze it and say whether summer or winter is going to come. (AS_4)
5. Make a sundial. Explain how you made it. (AS_5)
6. Where do you find moon at night; a) 2days before pournami b) 2days after amavasya (AS_1)

7. Why doesn't eclipse occur on every full moon day or on every new moon day? (AS_1)
8. Draw the different phases of moon. Arrange them in a order from pournami to amavasya. (AS_5)
9. Where do you find the pole star? (AS_1)
10. What is the difference that you find between polestar and other stars? (AS_1)
11. Why does polestar seem to be stationary? (AS_1)
12. Name some constellations. (AS_1)
13. Draw the location of polestar showing the direction from Great Bear. (AS_5)
14. Draw the diagram of the solar system. (AS_5)
15. How many planets are there in our solar system? What are they? (AS_1)
16. Look at the table-2 and name the smallest and the biggest planets in our solar system. (AS_1)
17. What are the planets you have seen in the sky? When do you observe those planets? (AS_3)
18. Are you curious about going to the moon? Why? (AS_2)
19. Among all 8 planets what is the special thing about earth? (AS_1)
20. How do day and night occur? (AS_1)
21. What are the other districts on the same latitude as your district? (AS_4)
22. Are the stars moving? if so why? (AS_1)
23. While observing the shadow of a stick from morning to evening, some questions arose in Ramya's mind. What may be those questions? (AS_2)
24. Is it possible to see the polestar for the people who live in the southern hemisphere of the earth? Why? (AS_1)
25. How do you appreciate the construction of knowledge abount the Universe by our ancestors? (AS_6)
26. What is the use of artificial satellites in our daily life? (AS_1)
27. We launched so many artificial satellites around our earth for different purposes. What is the impact of artificial satellites and their radiation on bio diversity? (AS_7)
28. Collect information about cosmic dust (wastage) from news papers, internet and make a poster on your school panel board about the consequences of cosmic dust. (AS_4)
29. Among eight planets of our solar system, earth is the only planet supporting life. Explain how we should protect our earth and its environment? (AS_7)
30. What are the questions that tease your mind when you look at night sky? (AS_2)
31. Even though we do not have clock, we can know the time by observing some shadows in day time. Think and discuss with your friends how we can know the time at night. (AS_2)
32. Why is Venus the brightest planet? (AS_1)