Taramandal

INFLATABLE DOME PLANETARIUM

USERS' HAND BOOK

NATIONAL COUNCIL OF SCIENCE MUSEUMS
CENTRAL RESEARCH & TRAINING LABORATORY
33 BLOCK-GN, SECTOR-V, BIDHANNAGAR, CALCUTTA-700091, India

Taramandal User's Handbook

Central Research & Training Laboratory
(National Council of Science Museums)
Block – GN, Sector – V
Kolkata 91
Web: www.ncsm.org.in
Email: ncsmin@giascl01.vsnl.net.in, ncsmin@vsnl.com

CONTENTS

PART – 1
Introduction

Why should we learn Astronomy?

Astronomy is probably the oldest branch of science arising out of man's curiosity for the night sky, the Sun and the Moon. Systematic observation of the motion of celestial bodies over a long period of time gave rise to formulation of calendars, which were useful for early agriculture and navigation. Early astronomical observations for prediction of natural phenomena namely phases of Moon, eclipses etc., gradually yielded deeper studies relating to the origin and formation of the universe.

Astronomy is a learning hobby. Its joys come from intellectual discovery and personal knowledge of the seemingly cryptic night sky. But you have to make these discoveries, and gain this knowledge, on your own. In other words, you need to become self-taught.

Have you ever looked at the mountains or ocean and experienced the peacefulness that only nature can provide? Seeing something so enormous and wondrous makes you feel so small and insignificant. It can stop you in your tracks and bring you back into reality. Try looking at the moon through a crystal-clear telescope and you'll feel like you are there. It's a thrill to see your first star cluster or galaxy as something more than a twinkling star in the night sky. It's amazing to imagine how large some of the things are out there. Looking through a good telescope, you are there. Not at work, not inside with the same TV shows; but free, even if only for a little while from the worries that are here on Earth.

The first thing is to look up into the sky as often as you can. If you go outside just after dark or just before dawn you might see a satellite pass overhead. It will look like an airplane, very high in the sky, without blinking lights. Look at the moon. Have you ever wondered why it is bigger at the horizon than when it is high in the sky? Well, it is not. It just looks that way. It'll play tricks on you. Try this; look at the full moon, extend your hand out toward it and cover the moon with your nail. Most likely you will completely cover it. Do this when the moon is at the horizon and again when it is high. You will see that it's always the same. As you learn little things like that you will be hooked.

Why should we go to a Planetarium?

Observation of night sky is a time consuming activity. To see a particular star one may have to wait even for months. To see the sky of another country at different latitude and at a different time, one has to travel quite a lot. In no case, one is able to see the sky of the past. But all these observations are in likelihood of a planetarium. One can simulate the sky for any place and for any time. One can place the planets, the Sun and the Moon in their proper places, make them move and one can travel forward or backward in time.

The development of useful problem-solving skills starts with the simpler skills of observing and categorizing. These skills are then combined with intermediate skills into the higher-level skills of inferring, predicting and communicating. Astronomy is a subject everyone sees. It deals with the universe beyond everyone's horizon. And astronomy is a subject that impacts on everyone's life.

The seasons, the tides, navigation and the establishment of the basic units of time are examples of important celestial influences on culture. More subtle, but profound, influences are found in art, mythology, literature and music. The study and use of what is called astronomy is as old as civilization itself. It is an integral part of the culture to be passed on from one generation to the next. A planetarium just fits in here. It is a great place to teach and learn Astronomy and the culture associated with it.

Taramandal – salient features

1. Low cost: The TARAMANDAL does not require a special building or dome. It can be set up in any ordinary hall. The cost of the unit is very low.
2. Portability: The TARAMANDAL can be set up and dismantled very easily, can be packed in small portable cases and programmes can be organised in rural schools requiring no special infrastructure.
3. Simplicity: The system is very simple in operation and easy to maintain.
4. Interaction: The traditional planetarium for the most part has become merely a vehicle for the transfer of "astronomical" facts and "space" information. It's no longer a place where you are allowed to figure something out for yourself. Taramandal offers the visitor a chance to explore the sky on his own. Here the instructor is no longer a presenter of facts. But, he is a guide to a self-exploration effort. Programs in Taramandal are designed with the interactivity at its focus where you can learn to observe and correlate.

Scope of Taramandal

The TARAMANDAL can be used to develop the following concepts in astronomy:

1. The concept of the celestial sphere
2. Diurnal motion
3. Constellations
4. Circumpolar stars
5. Seasonal stars and constellations
6. Latitude
7. Apparent stellar magnitude
8. Ecliptic - motions of the Sun
9. Equinoxes and solstices
10. Changing Sunrise and Sunset points
11. Phases of the Moon
12. Motions of the planets
13. Celestial Coordinates
14. The Sky at the equator and the sky at the poles.

In addition to its use as a miniature Planetarium, the Inflatable Dome can be used as an excellent dark room for projection of slides, for conducting experiments on light and for various educational purposes requiring a dark room.

PART II
Operation and Maintenance

The TARAMANDAL is a self-contained educational Planetarium ready for use anywhere indoor. The unit is portable and can be set in any hall having a height of 3.2 metres (10 ft. 6 inches). The package contains every item essential for holding programmes. Spares and repair materials are also provided in the package.

TARAMANDAL contains the following major items:-

1. Inflatable dome
2. Blower fan
3. Planetarium Projector with 10 attachments for showing phases of the moon, 5 planet projectors and 12 sun stoppers.
4. Star field projection cylinder
5. Manual slide projector
6. A set of 96 slides
7. Arrow pointer torch
8. Emergency electric lamp
9. Power board
10. Spares for repair and maintenance: -

    a) Projector
    1. Sun stoppers 8 Nos
    2. Cartridge fuses 2 Nos
    3. 'O' Rubber belt 2 Nos

    b) Spare lamps for
    1. Planetarium projector 4 Nos
    2. Pointer torch 1 No
    3. Projector side lamp 2 Nos
11. Text and worksheets for 24 programmes
12. Instruction Manual

Space Requirement

Clear floor space - 8 mts. x 8 mts. (25 ft. x 25 ft.)
Height - 3.2 mts. (10.5 ft.)

This requirement is just optimum (see plan of TARAMANDAL), a little more clearance on all sides is always helpful.

Electrical Requirement

Supply voltage: 230 Volts, 50 Hz. A.C.

Power requirements:

Blower fan: 80 watt
Planetarium Projector: 40 watt
Slide Projector: 250 watt

Visitor Intake

Capacity: 20 adults or 30 children at a time.

1. The Inflatable Dome

The inflatable dome is made of special type of fabric that is opaque, strong, flexible and fire retardant. However, the fabric, particularly the edge, being exposed to direct flame for sometime, may burn. It is, therefore, advisable not to bring any part of the dome in contact with direct flame under any circumstances.

The dome is inflated by blowing in air from the blower fan. There are several holes on the entrance duct, which let air out of the dome. Thus the dome remains in inflated condition with constant pressure inside. This mechanism maintains cross-ventilation inside the dome. Thus the dome remains a comfortable place to stay in. A word of caution, however, is that in case of a power-cut, the dome may collapse. But, it does so very slowly and since it is just loosely placed on the floor, all the insiders get ample time to just lift the edge on the floor and come out of the dome.

2. Blower Fan

The blower fan operates at 230 V, 50 Hz. A.C. and generates very little noise in motion. The fan provides the air necessary to keep the dome inflated. For smooth running, oil may be applied from time to time.

3. *Projector*

The projector operates on 230 V, 50 Hz. A.C. For further details see the section **Setting up the projector**.

4. *Star field Projection Cylinder*

The material of the cylinder is a photographic film. Stars and constellation patterns are photographed on it. The material is inflammable and takes scratch very easily. So, it demands very careful handling and it should preferably be stored always in the container supplied with it.

There are 12 small holes, which can be closed by magnetic stoppers. These holes mark the Sun's position every month. By removing one stopper the Sun for that month is exposed and is projected on the dome. The same holes can be used for projecting the Moon and the planets.

Dents can easily form on the surface of the projection cylinders. These dents can be smoothed out easily by applying little pressure around the area of the dent. Their immediate removal is necessary to prevent permanent damage. Scratches are easily caused by hard materials so it is always advisable to put the cylinders inside the cushioned cases supplied with the cylinders. Outside surface of the cylinders may be cleaned by soft cloth and film cleaner.

Setting up TARAMANDAL

Before setting up TARAMANDAL

1. Check the locations of the electrical points in the room. (It will be easier if the blower fan end is close to them).
2. Decide where you will want the entrance tube and the inflation tube to be.
3. Look at the location of all of the TARAMANDAL parts in the packing boxes, before you take them out. Remember, you will have to repack everything the same way, else, it would be difficult to fit everything in their respective packs.

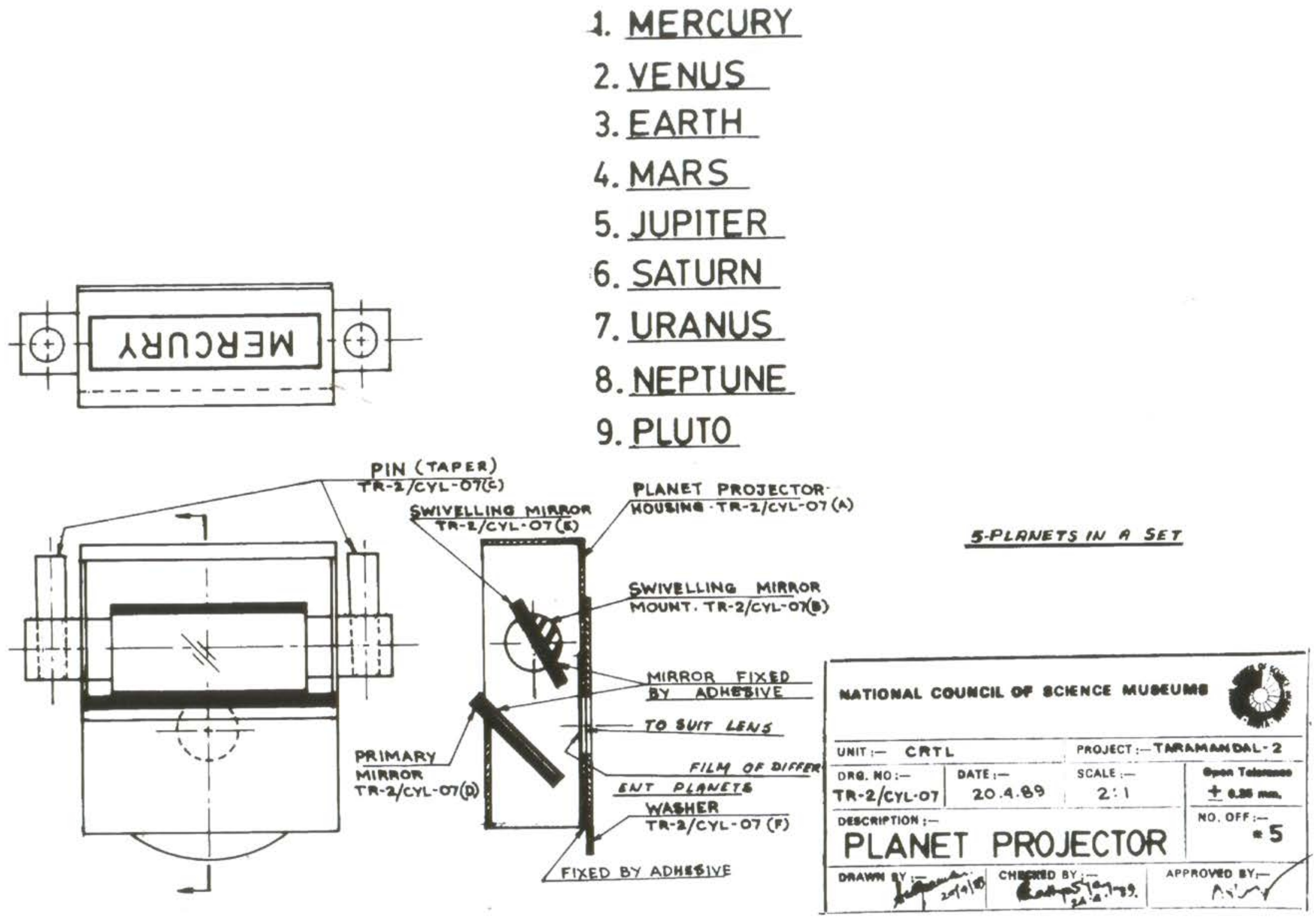
To set up TARAMANDAL

1. Remove the dome from its case and unbuckle the straps.
2. Unroll the dome on a clean floor until it is fully extended.
3. Unfold the dome so that the tubes are completely exposed. The dome should be roughly circular in shape. The inner surface of the dome should not be visible after unfolding. Avoid dragging the dome across the floor.
4. Locate the Inflation duct. It is the smaller of the two ducts. After arranging the tubes as shown in the photograph (forming a 90 degree angle), tie the tube round the fan's protruding frame with a cord. Plug in the fan and turn it on.
5. As the dome starts to fill with air, walk around it and adjust it into a circular shape. Make sure the tubes do not have any kink or unnecessary bend. Holding the entrance terminal closed until the dome is about completely inflated can speed up inflation.
6. Set up the projector outside the dome and then carefully lift the dome edge and take it under the dome or bend over and walk through the entrance tube, carrying the projector.

7. Slip an extension cord under the edge of the dome and plug in the projector. By turning the side lamps of the projector on, you will have enough light to set the stand. The box containing the projector is suitable to be used as the planetarium projector stand. To use it that way, place it directly under the centre of the dome. The projector can be put over it.

Setting Up The Projector

1. After the stand and the projector are set up in the centre of the dome, carefully remove the packing material from the projector. Be sure to remove the black plastic cap, which protects the projection bulb.
2. Test both the side lamps and the projection lamp for operation.
3. When the "Daily Motion" switch is in the "On" position, a motor turns the cylinder slowly simulating daily East-West motion of the celestial bodies. Put it on to show movements of stars, Moon, Sun and planets.



1. MERCURY
2. VENUS
3. EARTH
4. MARS
5. JUPITER
6. SATURN
7. URANUS
8. NEPTUNE
9. PLUTO
MERCURY
PIN (TAPER) TR-2/CYL-07(C)
SWIVELLING MIRROR TR-2/CYL-07(E)
PLANET PROJECTOR HOUSING TR-2/CYL-07 (A)
5-PLANETS IN A SET
SWIVELLING MIRROR MOUNT. TR-2/CYL-07(B)
MIRROR FIXED BY ADHESIVE
TO SUIT LENS
FILM OF DIFFERENT PLANETS
WASHER TR-2/CYL-07 (F)
PRIMARY MIRROR TR-2/CYL-07(D)
FIXED BY ADHESIVE
NATIONAL COUNCIL OF SCIENCE MUSEUMS
UNIT :— CRTL
PROJECT :— TARAMANDAL-2
DRG. NO :— TR-2/CYL-07
DATE :— 20.4.89
SCALE :— 2:1
Open Tolerance ± 0.25 mm.
DESCRIPTION :— PLANET PROJECTOR
NO. OFF :— 5
DRAWN BY :—
CHECKED BY :—
APPROVED BY:—

4. Place the cylinder support in a completely horizontal position. Always place the cylinder on the base in upright condition and take it out in the same fashion. Let the notch at the base of the cylinder slip into it. Now slide the Velcro hold-downs into position directly below the Velcro on the cylinder base and fix the cylinder tightly.

5. Find the time of night you wish to set the projector for on the "Hour Scale". Rotate the cylinder support until the proper month appears beneath the hour you selected. The machine is now set for operation. Rotate the cylinder support (Perspex disc) to turn the cylinder.

6. Find your location on the latitude map. By adjusting the cylinder support position this location against the "Alignment Edge" of the projector. The machine is now set for that latitude.

7. After setting up the TARAMANDAL select the programme and keep all materials (including copies of the work sheets) required for the programme ready. Details of requirements and work sheets are given along with respective programme sheets.

8. While delivering a planetarium lesson, dim the lights slowly to allow the students to adjust their vision with the darkness. Switch the projection lamp on and increase the brightness slowly. Life of projection lamp gets shortened when it is operated at its maximum brightness continuously. Always dim it down after your students adapt to the darkness of the dome.

   Same procedure is to be followed whenever the TARAMANDAL is set up for a programme. During the programme if there is a power failure, tell the students not to panick. Everybody can get out of the TARAMANDAL by lifting up the edge.

Using the Slide Projector

The 35mm Slide Projector can be used to project slides inside the dome and to conduct various programmes. During a planetarium show pictures may be projected on the dome to show the planets, galaxies, nebulae and other interesting objects in different parts of the sky. (Example - while showing the constellation of Taurus, the Crab nebulae may be projected on the constellation, similarly the ring nebula in Lyra may be projected to show its position in the sky). An adjustable mirror is attached to project the pictures at different parts of the dome. In addition to these, independent programmes may also be conducted from time to time.

Using the Starfield Cylinder to Simulate the Motions of the Sun, Moon and Planets

SUN

1. Place the starfield cylinder on the projector in a completely horizontal position.
2. Twelve metal stoppers are located around the cylinder along the line of the ECLIPTIC. Each stopper is held in place magnetically. To remove them, gently pull out a stopper and keep it in a safe place.
3. Removal of a stopper will create the sun for that particular month mentioned below the stopper.

The actual dates of the Sun's position on the cylinder are given below:-

January 23	April 23	July 23	October 23
February 22	May 24	August 30	November 18
March 24	June 22	September 20	December 23

MOON

To set up the Moon in any phase for any month :-

1. Put the starfield cylinder in a horizontal position.
2. Select the month you wish to simulate.
3. Remove the stopper directly over the chosen month's position on the month scale.
4. Select the phase of the Moon you want to simulate.
5. Use the "Table of Moon Phase Locations" to find where to place the desired Moon phase transparency.
6. Remove the stopper from the correct place and insert the desired Moon phase transparency.
7. Refer to the table to find out which stopper is to be removed to show the lunar phase for the particular month selected.

PLANETS

To set up planet projector:-

1. Obtain the exact location of the planets from ephemeris or any other source. This information will enable you to project the planet you want to simulate at the exact spot on the dome in relation to the constellations and the ecliptic.
2. Remove the stopper from the correct place.
3. Place the planet projector over the hole (it will attach magnetically).
4. Line up the planet directly over the hole so that light shines directly through the hole.
5. Once the planet is centred over the light source, use the small white rod (located on the side of the planet projector) to position the planet. The rod allows the planet projection to move along the ecliptic. Do not force the rod beyond its stopping point or the small reflector may break.
6. The planet projector itself may be rotated 360 degrees in order to project the planet at any place.

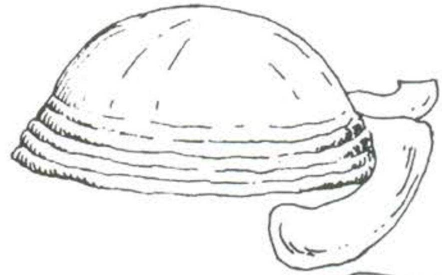
NOTE: The planet Mars is tinted red; Saturn is yellow (its ring cannot be seen with the naked eye); Jupiter, Venus & Mercury are all brilliant white.

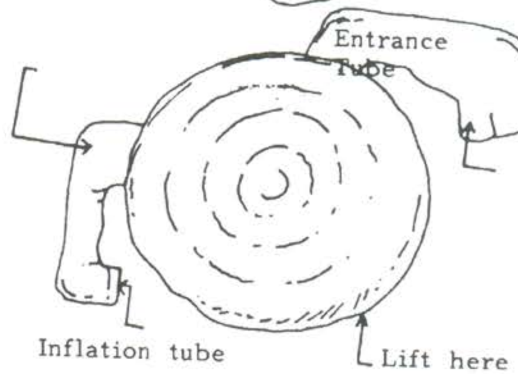
TABLE OF MOON PHASE LOCATION OVER MONTH SCALE ON THE PROJECTOR

Sun Position	New	First Crescent		First Quarter	First Gibbous		Full Moon	Last Gibbous		Last Quarter	Last Crescent	
Jan	-	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feb	-	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Mar	-	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Apr	-	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
May	-	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Jun	-	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Jul	-	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Aug	-	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Sep	-	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Oct	-	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Nov	-	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Dec	-	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov

Packing up TARAMANDAL

After everyone leaves the dome, turn the fan off and lift off an edge of the dome as shown in the diagram. Allow the air to escape. The dome would fall into a crescent shape. Unfasten the fan from the inflation duct and put the fan into its case.



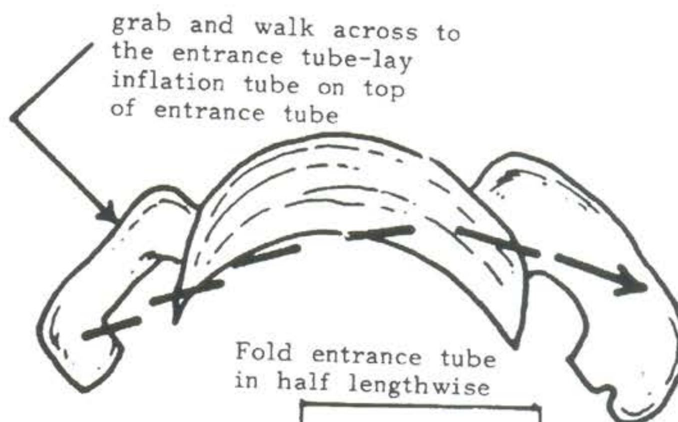


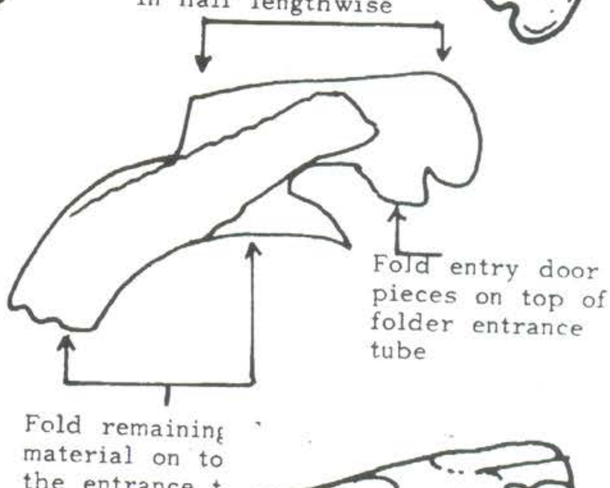
Dismantle the projector and carefully store all of its pieces in their proper compartment in the packing case. Make sure to put the protective packing material including black plastic cap, back on the projector.

Packing the Dome

1. Grab the fan-end of the inflation duct
2. Take it across to the entrance duct
3. Lay the inflation duct on top of the entrance duct
4. Fold entrance duct around half of its length
5. Fold the two entry door pieces on top of this
6. Fold the remaining dome material on top of the entrance tube until the dome resembles the diagram.

Note: The entrance tube forms a protective layer on the outside of the dome after it is rolled, and thus adds extra protection to the viewing surface.

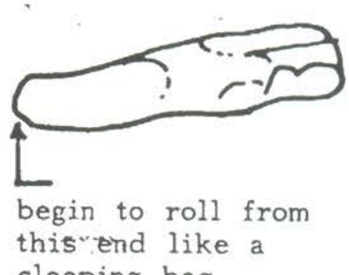




N.B. If the programme is conducted at one location only, it is best to deflate the dome and let it lie in on the floor. Repeated folding may cause damage to the material.

The Dome must be rolled very slowly

Roll the dome up like a sleeping bag. Two people rolling the dome will give the most compact shape. Be sure to squeeze out all excess air as you roll. This can be done by kneeling or sitting on the dome several times as you roll it. Do not trample on it with shoes.



Care and Replacement of the Projection Lamp

The projection lamp is a halogen lamp designed to operate for approximately 10 hours with the projector at its brightest setting. Avoiding sudden peaking of the brightness may prolong the life of the bulb. To extend the lamp life:

- Use maximum illumination for only a short period;
- Reduce brightness after dark adaptation;
- Avoid turning the lamp to full brightness suddenly;
- Cover the lamp with the plastic case;

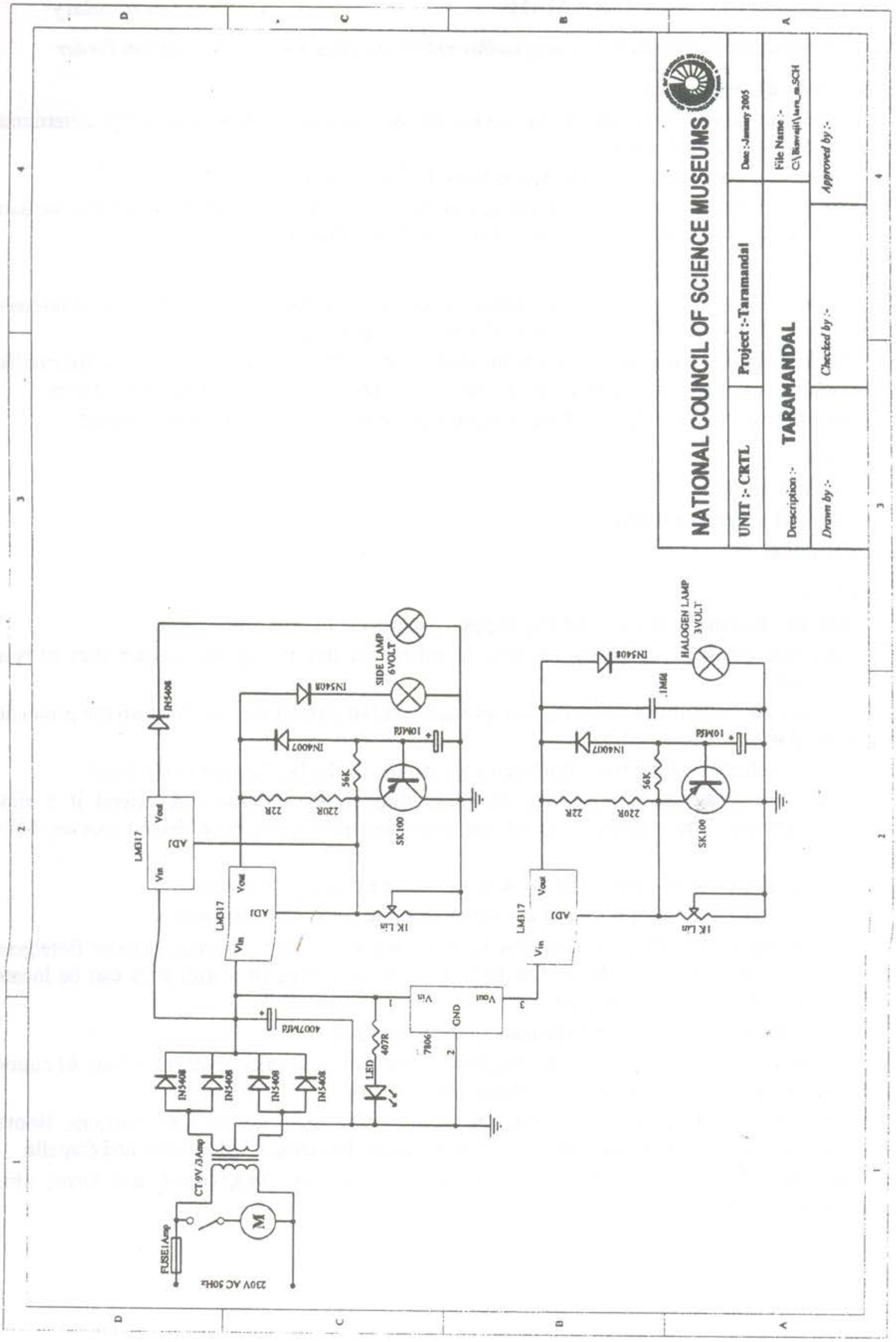
To replace the projector lamp:

- Turn the power off and unplug the projector
- Allow the lamp to cool if it was glowing.
- Pull the old lamp out from its socket.
- Straighten the leads of the new lamp and adjust their spacing to about 4mm.
- Slowly insert the leads into the two holes in the socket. Take care not to bend the leads and stop when resistance is met.

N.B. The halogen lamp may shatter if it is scratched or damaged. It should be handled with proper care. Always operate with the cylinder in place. Use clean tissue paper to hold the lamp.

General Safety Rules

1. Never allow smoking, open flames or any heat source in and around the dome.
2. Always show the participants that they can get away quickly by lifting the dome wall.
3. Never use the dome outdoor.
4. Regularly check the connecting electrical cords for planetarium projector, blower fan and slide projector for any possible leakage, which may cause fire from short circuit.


NATIONAL COUNCIL OF SCIENCE MUSEUMS
UNIT :- CRTL
Project :-Taramandal
Date :-January 2005
File Name :- C:\Biswajit\tara_m_SCH
Description :- TARAMANDAL
Drawn by :-
Checked by :-
Approved by :-
230V AC 50Hz
FUSE1Amp
M
CT 9V /3Amp
IN5408
4007MFd
LED
407R
7806
Vin
GND
Vout
LM317
Vin
Vout
ADJ
22R
220R
56K
SK100
IN4007
10MFd
IN5408
SIDE LAMP
6VOLT
1K Lin
.1Mfd
HALOGEN LAMP
3VOLT

TARAMANDAL PROGRAMME — Grade - Elementary

Finding stars and constellations using stellar reference points and constellation finder

Concepts to be developed

1. Some well-known stars and constellations can be used as reference points for determining the positions of other stars.
2. Some prominent stars or regular geometrical figures help to locate other stars.
3. Relative proportions of the constellations given in a star & constellation finder and the same in the real sky give an idea of the actual area of the constellations.

Objectives

1. The students will be able to demonstrate the use of some stars and constellations as reference systems for determining the positions of other stars and constellations.
2. The students will be able to relate some stars in the form of regular geometrical figures like, triangles, rectangles and squares and locate other stars by using these reference figures.
3. The students will be able to use the constellation finder in locating stars and planets.

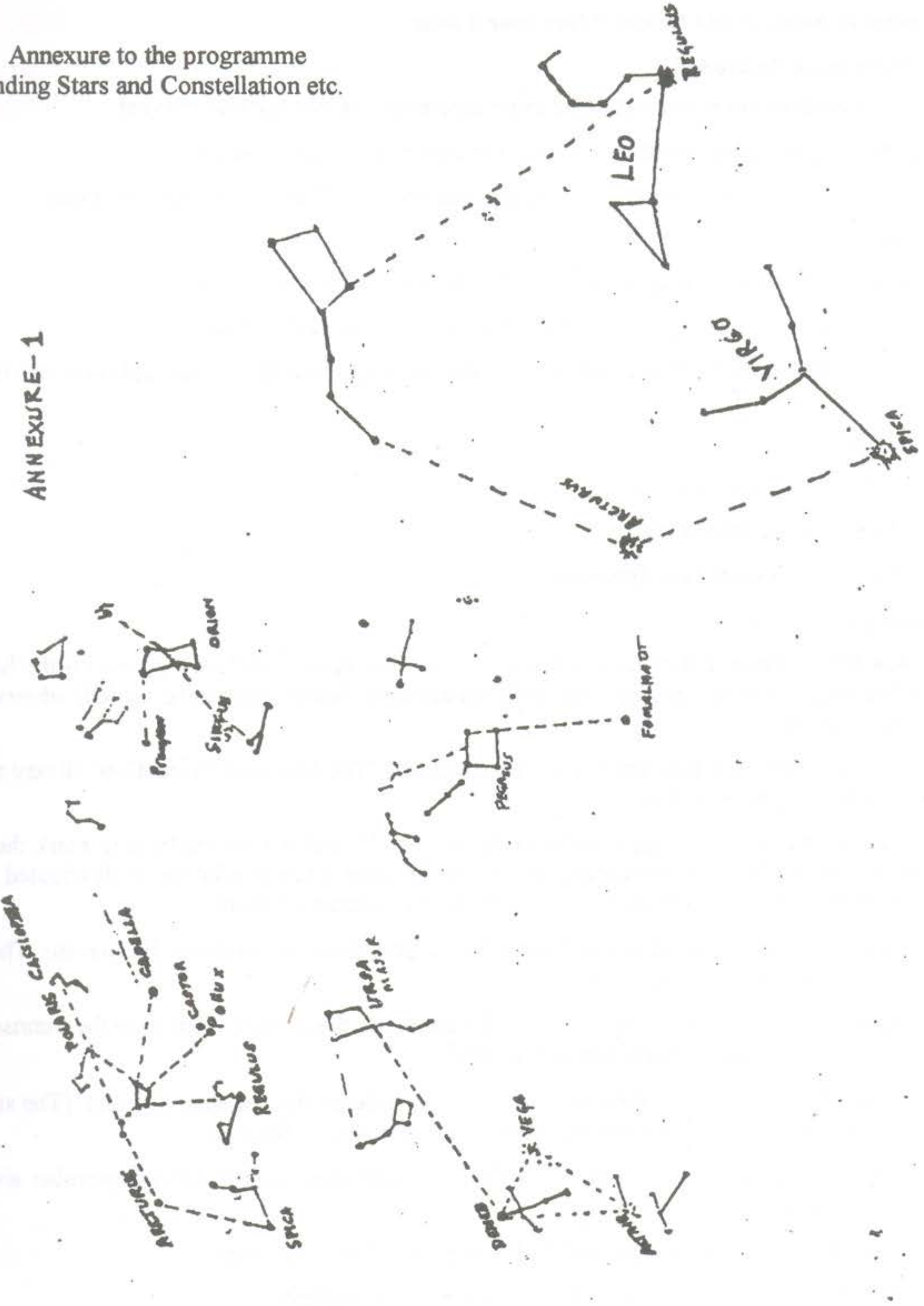
Materials

1. Standard set up
2. Star field projection drum
3. Star finder

Procedure

1. Help the students to identify the Big Dipper. Locate the pointer stars.
2. Using the arrow torch, tell the students to extend the line joining the pointer stars to reach the Polaris.
3. To make the students understand that all stars revolve around the polaris, turn the projection drum slowly.
4. Let the students find the star, which joins the handle of the Big Dipper to the bowl.
5. Follow the imaginary line joining the stars through the Polaris and extend it 5 times approximately. The students will find the constellation of Cassiopeia shaped like an 'M' or 'W'.
6. Turn the projector off and rotate the drum through a quarter revolution.
7. Again switch on the projector and ask the students to relocate Cassiopeia.
8. The constellation of Orion is found by locating two stars – the yellowish red star Betelgeuse and the bluish white star Rigel. The belt of Orion consisting of 3 dim stars can be located half way between these two stars.
9. Follow the line joining these three stars to the south- east.
10. The line points to a bright star, the brightest of the stars in the sky (except the Sun, of course) Sirius in the constellation of Canis Major, the Big Dog.
11. From the diagram (see Annexure-I) the students can easily locate Leo, Gemini, Bootes, Virgo and the stars Regulus, Castor, Arcturus, Spica, Fomalhaut, Aldebaran and Capella.
12. They may also find out Cygnus, Aquila, Lyra and the stars Vega, Deneb and Altair, which form a triangle.

Annexure to the programme
Finding Stars and Constellation etc.



TARAMANDAL PROGRAMME

Grade - Elementary

Changes in Sunrise and Sunset Times over a year

Concepts to be developed

1. The Sun does not rise or set at the same time every day throughout the year.
2. The Sun rises at the North Pole on a fixed date and sets on a fixed date.
3. The Sun rises exactly in the East and sets exactly in the West on two days in a year.

Objectives

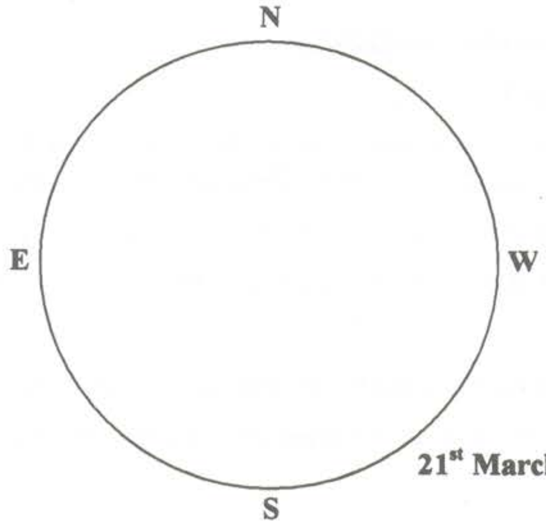
1. The students will be able to tell when the Sun rises early and sets late.
2. The students will be able to tell when the Sun rises late and sets early.
3. The students will be able to account for the cause of 6 months of day and 6 months of night at the poles.

Materials

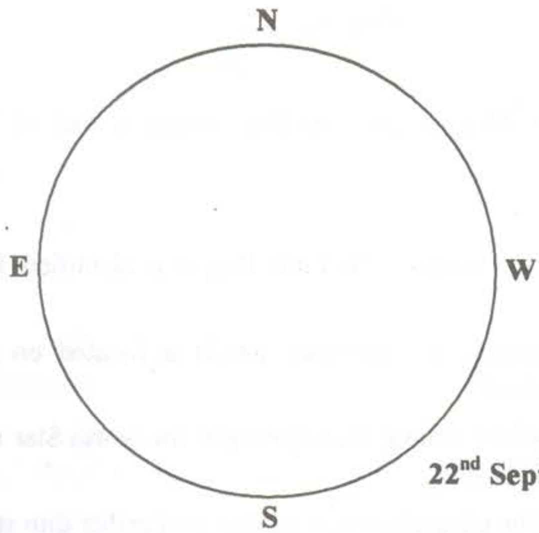
1. Standard set up procedure
2. Starfield projection drum
3. Horizon worksheet (see Annexure-I)

Procedure

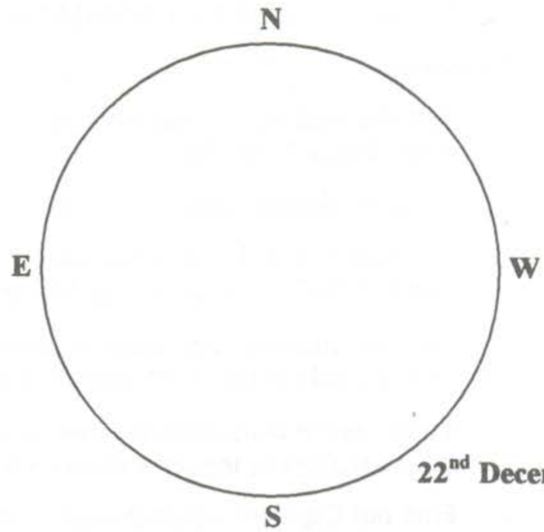
1. Ask the students if they have noticed that the Sun rises at different points on the horizon. [The students will come up with different answers. Some might have actually observed the phenomenon.]
2. Ask the students if they agree with the statement "The Sun rises in the East".[Every student is likely to agree with this]
3. Now set the drum for approximately September 22 and tell the students to mark the rising point on the horizon worksheet and write the date. [The worksheet is distributed to the students who will orient the horizon with the Taramandal horizon]
4. Now rotate the drum to about December 22 and show the students the Sunrise. They will mark the point on the worksheet.
5. Again rotate the drum to about March 20 and show the Sunrise. This time the Sunrise point will coincide with the 22nd September point.
6. Rotate the drum to 21st June position. Let the students plot the Sunrise point. [The students have noted the Northern most and Southernmost points of Sunrise]
7. Ask the students which is exactly the East [Students may suggest 22nd September and 20th March point]
8. Stress the point that the Sun rises North or South of the East point.
9. Make the Sunrise on any other day suggested by the students.
10. Tell them to plot the rising point on the horizon. They should notice that the Sunrise points move between two extremities i.e. 22nd June and 22nd December.
11. Set the cylinder for North Pole and open June and September Sun stoppers. Explain the cause of 6 months of day at the Poles.



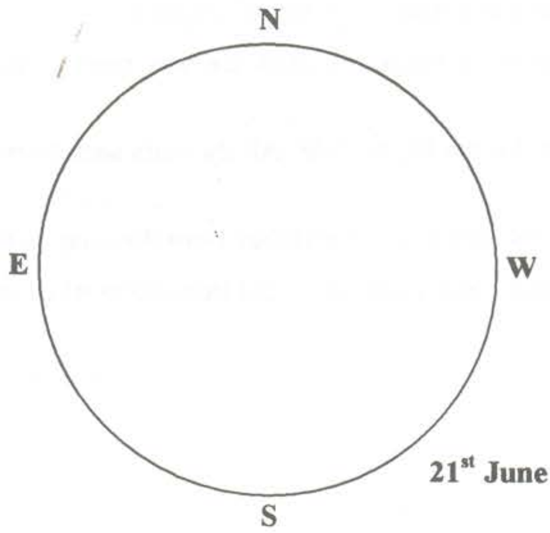
21st March



22nd Sept



22nd Decem



21st June

TARAMANDAL PROGRAMME

Grade Level - Elementary

Identification of Circumpolar Constellations

Concepts to be developed

1. Most of the Stars move from east to west. They rise and set. But some do not rise or set, but appears to be revolving round a point - These are the circumpolar stars.
2. All stars revolve around the same point in circles of different diameters.
3. Circumpolar region depends on the position of the observer on the Earth.

Objectives

1. The students will be able to identify circumpolar constellations.
2. The students will be able to differentiate between the circumpolar regions at different latitudes.

Materials

Standard set up of the TARAMANDAL with Starfield Cylinder.

Procedure

1. Ask the students to identify the Big Dipper. Discuss that the Big Dipper is part of the constellation Ursa Major.
2. Using the pointer stars find out the Pole Star.
3. The Pole Star is the tip of the handle of the Little Dipper. The Little Dipper is identified. It is a part of the constellation Ursa Minor.
4. Tell the students that there is another constellation Cassiopeia which is located on the opposite side of the North Star from the Big Dipper.
5. To locate the constellation, draw an imaginary line joining the pointers to the North Star and extend the line to the same distance from the Pole Star.
6. Find out Cepheus, which is near Cassiopeia. The constellation is made up of rather dim stars and its shape is basically a triangle on top of a square.
7. Set the planetarium for equator. All stars are now seen to rise and set. No constellation is circumpolar.
8. Set the planetarium for the North Pole. All the stars seen from the Northern hemisphere are circumpolar.
9. Ask the students what they would see if they were standing on the South Pole.
10. Ask the students which constellations would be missing when one stands at the South Pole.

TARAMANDAL PROGRAMME

Grade Level - Elementary

All constellations are not visible throughout the year

Concepts to be developed

1. The stars rise and set daily at different times.
2. During night, when one side of the Earth is turned away from the Sun, we see the stars that are above us.
3. If we look at the night sky six months apart, the stars and constellations will be completely different. This is because we now look at opposite direction of the sky at night.
4. The locations of stars far away from the North Pole changes throughout the year.

Objectives

1. Students should be able to demonstrate an understanding of the reasons for the apparent motion of the stars throughout the year.
2. Students should be able to demonstrate an understanding of the seasonal changes in stellar location due to the revolution of the Earth around the Sun.
3. Students should be able to demonstrate an understanding of the differences in stellar positions at the equator versus the Polar Regions.

Materials

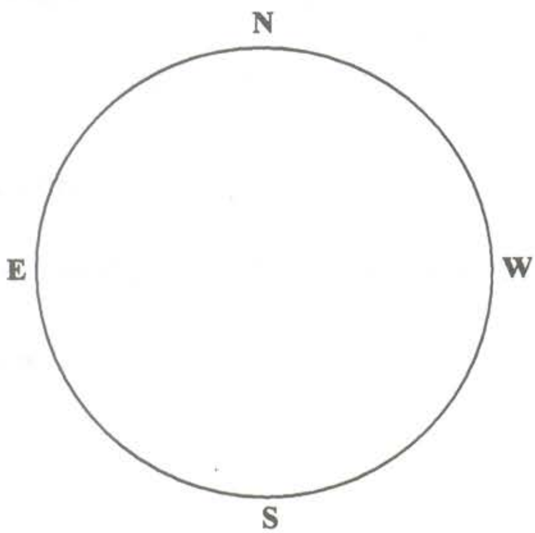
1. Standard set up
2. Starfield projection drum
3. Horizon circles

Procedure

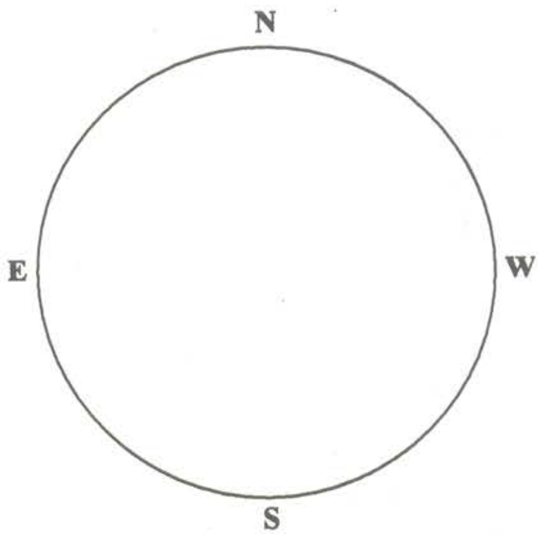
1. Let the students face the Eastern horizon and locate a star or a constellation on the Eastern horizon. [Example: November 15 at 9 P.M. Orion would be in the Eastern horizon]
2. Turn on the daily motion and go through a complete cycle till Orion rises again.
3. Make the students understand this motion as the daily motion i.e. to the rotation of the Earth around its axis.
4. Locate the Big Dipper or Cassiopeia, whichever is on top (if the observation is done in December, Cassiopeia will be on top)
5. Turn the projection drum month-by-month and let the students observe or chart the locations of these constellations through the different seasons.
6. Locate other constellations and show their shift through the seasons.
7. Set the sky for latitude 90° N (i.e. the North Pole) and locate the Big Dipper, Polaris and some other familiar constellations.
8. Turn the projection drum slowly to make the students understand the motions of the stars viewed from the North Pole.
9. Change the latitude gradually from 90° to 0 ° i.e. the equator.
10. Ask the students to mark the changes.

11. Let the students understand that as one travels from North to South, more part of the southern sky will be visible.

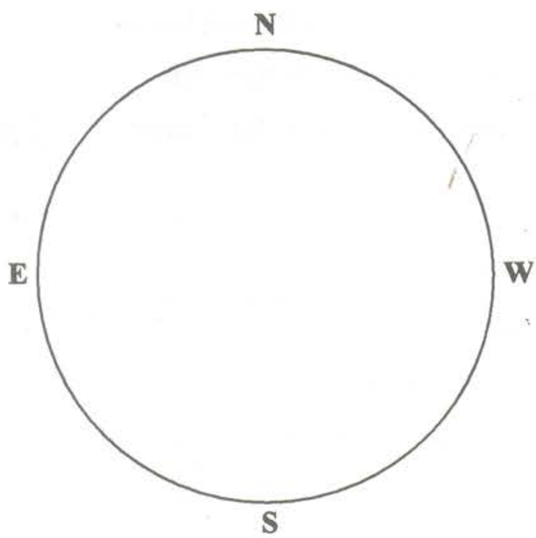
12. Set the drum for the equator. The North Star will lie just on the Northern Horizon. Since there is no star close to the South Pole it is not possible to locate the South Pole with similar method.



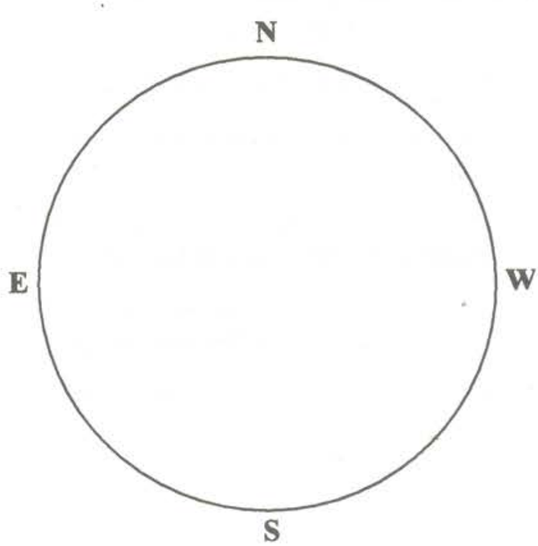
Spring



Summer



Autumn



Winter

TARAMANDAL PROGRAMME

Grade-Elementary-VI

Can you identify these Stars?

Objective

- Students will be able to locate stars in the TARAMANDAL and in the sky by using a Star Finder.
- Students will be able to identify specific stars in the night sky for any specific date with the Star Finder.
- Students will be able to locate bright reference stars and find out constellations.

Materials

1. Star finder construction material
2. Pen lights
3. Clip board
4. Pencils

Procedure

1. The TARAMANDAL is set for a visit (The preliminaries mentioned in the introductory course may be followed)
2. Distribute the Star Finders (already prepared) to the students (It is advisable that the students come with the Star Finders prepared beforehand. In this case these may be sent to schools in advance with the instructions for making the star-finder as a pre-visit activity).
3. Divide students into groups of two. One will shine the torch and the other will work on the star map.
4. Select the date, month and time for which the observations are to be made and tell the students to set their Finders by turning the star disc until the date printed on the disc coincides with the time of observations.
5. The room lights are made dim and the projection lamp is brightened so that the bright stars show up. Tell the students to align the star map with the four directions of the TARAMANDAL. The star map is held in such a way that the directions marked on the finder coincide with the TARAMANDAL NSEW.
6. Ask the students to locate the bright stars on the dome by consulting the star map, tell the names. These stars will be the reference stars for finding the constellations.
7. After dimming the room lights further to make more stars appear, ask the students to identify a constellation, which you show by using Pointer Torch.
8. Switch off the room lights so that the whole sky is visible and ask the students to verify their findings. They will also find the constellation outlines by referring to the reference stars.
9. Tell the students to retain the star charts and to use them to find the stars and constellations on the real sky.

Assembling the Star finder

Pattern "A" - Time Frame

Cut off all the shaded areas. Fold back at fold lines. Insert a heavy card board piece between the time frame and the fold flaps. The card board should be the size of the time frame after folding. Tape the flaps down securely on the back of the card board. This frame will hold the star wheel.

Pattern "B" - Star Wheel

Cut out the wheel. Paste down on a thick paper and trim the edges. Insert the star wheel in the time disc frame as constructed above. The star wheel is free to move in a circular fashion.

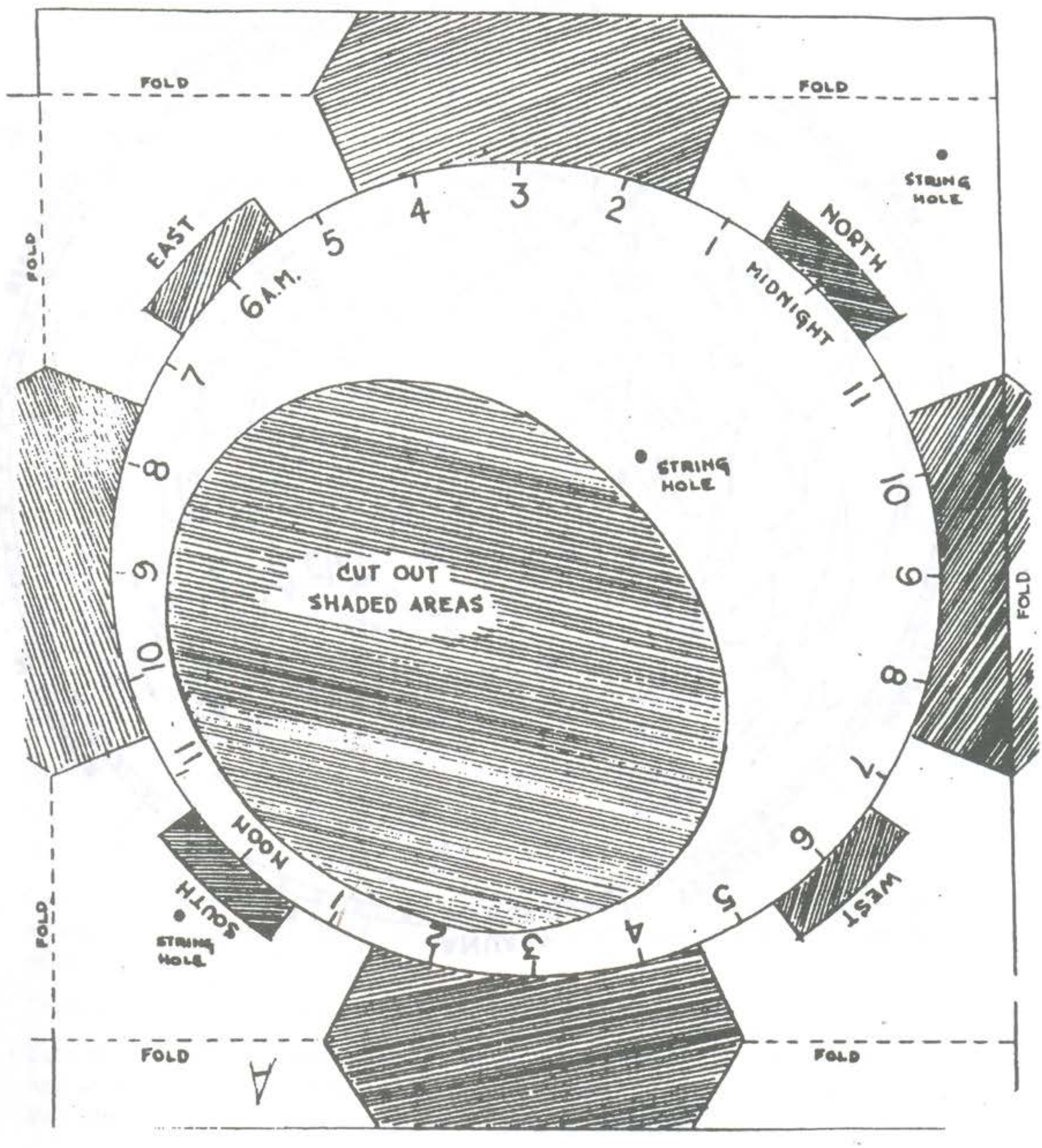
How to Use

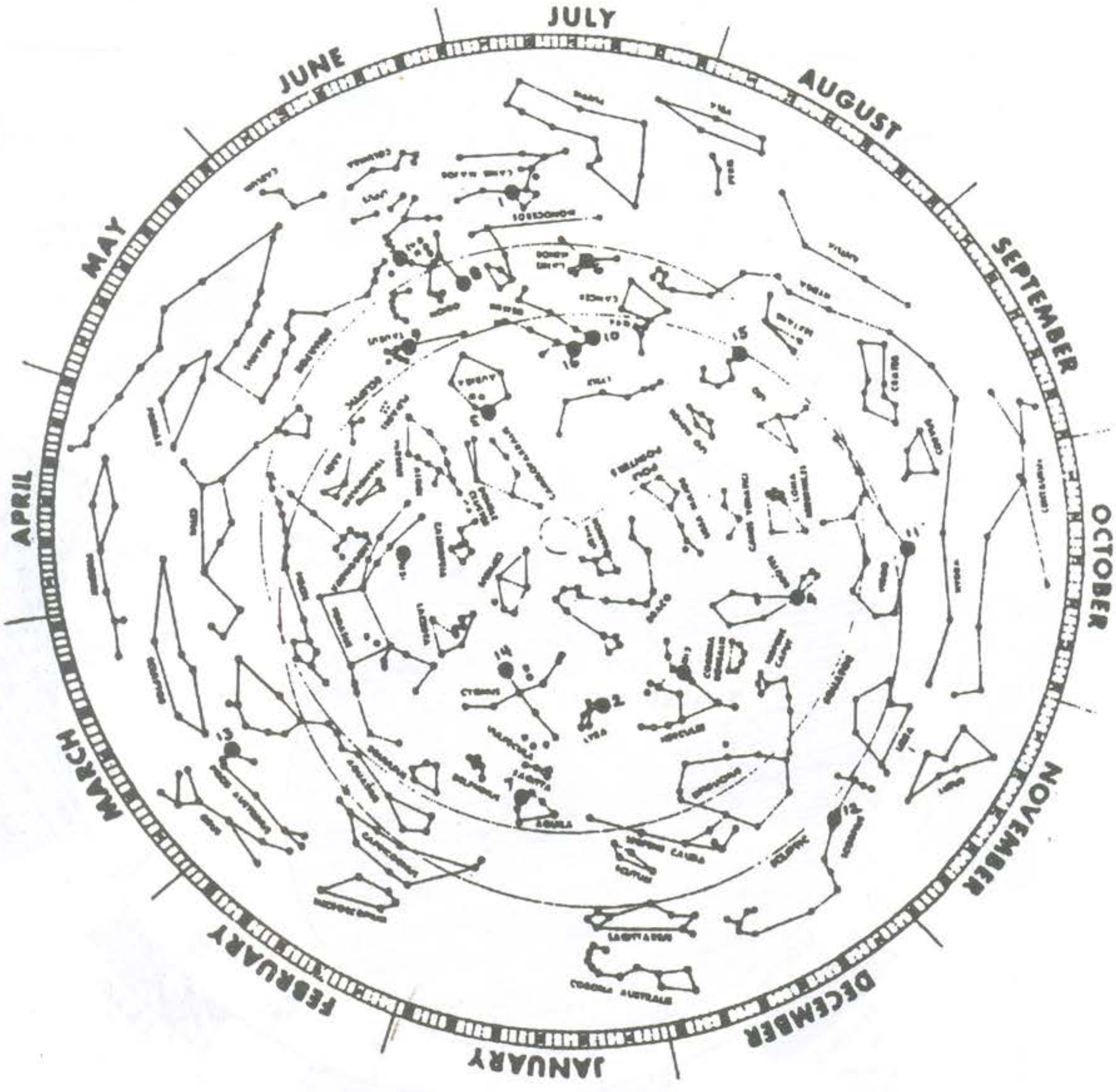
Turn the Star Wheel until the date on the star wheel corresponds with the time and day of the month for which the observation is intended.

Hold the Star Finder overhead with its face down with the North of the star finder pointing towards the North Pole of the Taramandal or that in the real sky.

Locate star positions on the Star Finder.

Look at the sky in the same position on the dome or real sky to locate the stars and constellations.


FOLD
FOLD
FOLD
FOLD
FOLD
FOLD
FOLD
FOLD
STRING HOLE
STRING HOLE
STRING HOLE
EAST
NORTH
WEST
SOUTH
MIDNIGHT
NOON
6 A.M.
CUT OUT SHADED AREAS
A


JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE

TARAMANDAL PROGRAMME

Grade Level - IV

Visibility and Movement of the Stars

Concepts to be developed

1. Stars cannot be seen due to other stronger light sources.
2. The constellations are imaginary star configurations.
3. The constellations move from East to West daily and they shift positions also over long periods like a month or so.

Objectives

1. Students may find out best places and time for observing the stars.
2. Students may develop unconventional pictures of the constellations.
3. Students will be able to demonstrate that a particular constellation will not be visible throughout the year at a particular place. They may even be able to demonstrate the principles of the calendar.

Materials

1. Standard set up procedure
2. Star field projection drum
3. Sun simulator (40 watt lamp with variac. This may be prepared separately before the show)

Procedure

1. Turn the star field lights to its lowest setting. No stars are seen. Ask the students what they see.
2. Adjust the star field intensity knob gradually and ask the students to tell when they see the first star.
3. Discuss the concept that the stars are of different brightness, which is called "magnitude".
4. Now turn the projector knob to about half turn back from full brightness and slowly turn on the variable light source. Ask the students to compare this to the rising Sun.
5. Gradually turn on the variable light source to full brightness and tell the students that although the stars are still there, the light of the variable light source is stronger than the light of the stars rendering them invisible.
6. Discuss that in real situation the same thing happens.
7. Turn the side lamp to a minimum and turn on the star field to full brightness. Now gradually turn on the side lamp till some faint stars disappear. Tell the students that in cities the lights also interfere with the visibility and the villages are better places for observing stars.
8. Gradually brighten up the side lamp to about the full brightness in 4 or 5 stages.

   At each stage, tell the students that the brightness of the side lamp represents the waxing Moon, which also, being brighter than the stars, does not allow us to see all the stars except a few bright ones.
9. Now tell the students that in cities the lights, smoke and dust do not allow all stars to be visible and ask them to suggest places and time to get clear view of the sky.

TARAMANDAL PROGRAMME Grade Level: IV-VI

(This may also be shown to students of higher classes)

The Changing Sky

Concepts to be developed

1. The stars rise and set as a result of diurnal rotation of the Earth.
2. The pattern of star movement depends on the North-South position of the observer on the Earth's surface i.e. the latitude of the place.
3. If the sky is viewed from the North Pole, some stars will never set.
4. If viewed from the Equator, all stars will rise and set.
5. If viewed from a place between the Pole and the Equator, some stars will set, but some will not.

Objectives

1. Students will be able to explain, demonstrate and record graphically the connection between the diurnal motion of the stars and the earth's rotation around its axis.
2. By seeing the star movement, the students will be able to find out the latitude of the observer.
3. They will be able to explain the reasons for these variations.

Requirements

1. Worksheet for plotting star movements
2. Pencils
3. Pen Lights

Procedure

1. Set the TARAMANDAL for home latitude
2. Orient the students to cardinal points N.S.E.W.
3. Show daily motion and ask for observation. The students will find out that the stars are moving.
4. Ask them if some stars move differently from the others. [The students will find that some stars set and some do not]
5. Distribute the worksheet
6. Identify the Pole Star and ask the students to plot it on Circle 'A'. [The students must find out that the Polaris does not move throughout the night]
7. Run daily motion and ask each group to plot the movements of some bright stars both circumpolar and setting.
8. Ask the students to develop explanations for such movements.
9. Tell the students that the TARAMANDAL can simulate sky for any location on the Northern hemisphere and ask them where they want to transport themselves for viewing the sky.

10. Select two locations, one near the Pole and the other near the Equator. Run the daily motion in each case and tell the students to plot the motions of the bright stars on circle B&C. It is important that they plot the positions of the Pole Star first before plotting other stars.

11. Ask the students to classify the stars according to the movement into two classes - Those who do not set and those who set. Use the appropriate terms the Circumpolar and the Equatorial.

12. Now select a latitude yourself and ask each group to locate the position by observing the star movement.

13. Collect the work sheets on which the Group names are written like N, S, etc. and evaluate.

14. Tell the students to retain the work sheets and do more work at home by looking at the night sky.

The change in the movements of the stars with latitude can be demonstrated using a round bottom flask of 500c.c. or 1 litre capacity (see figure).

1. Tell the students to consider the surface of the flask as the celestial sphere. The Celestial Equator, an extension of the Earth's Equator onto the celestial sphere, is marked on it.

2. The Polaris is shown by inserting a straight wire through the centre of a cork used as stopper. The wire may be taken as an extension of the earth's axis.

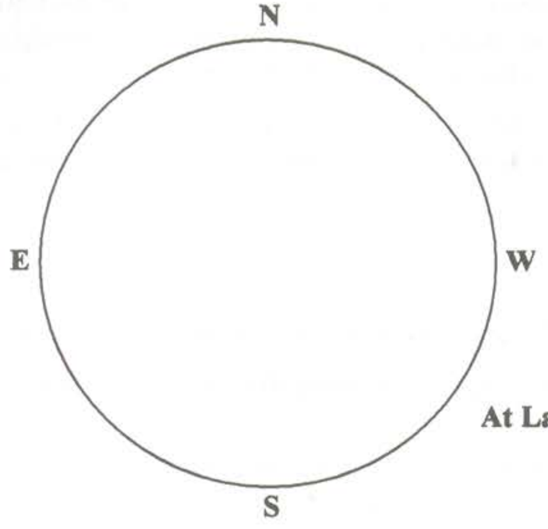
3. Fill half the flask with coloured water. This is the horizon of the observer who is supposed to be at the centre of the flask.

4. Make the students understand that the observer sees only half of the sphere i.e. 180 degrees. The other half is always below the horizon.

5. With this model the students may comprehend from which northern latitude a particular star in the southern hemisphere will not be visible at all.

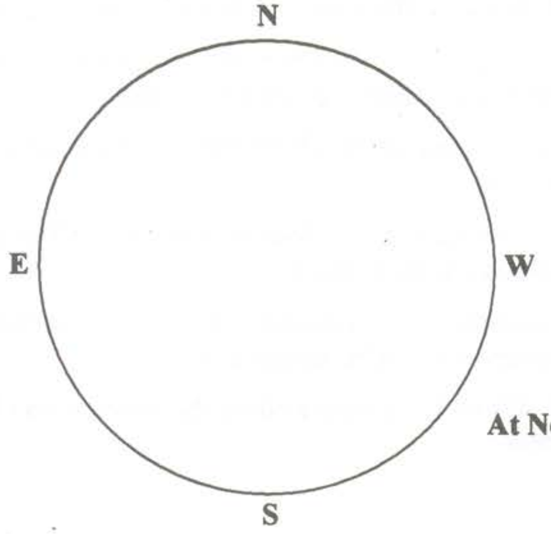
6. The students may be offered to speculate about the movements of the stars if the Earth were rotating at different rates.

A



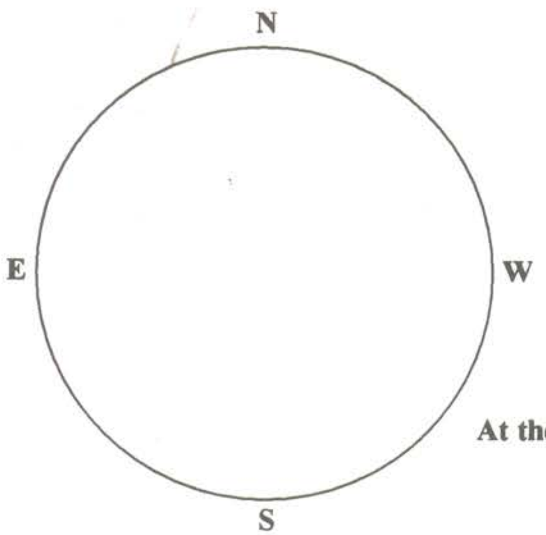
At Latitude

B

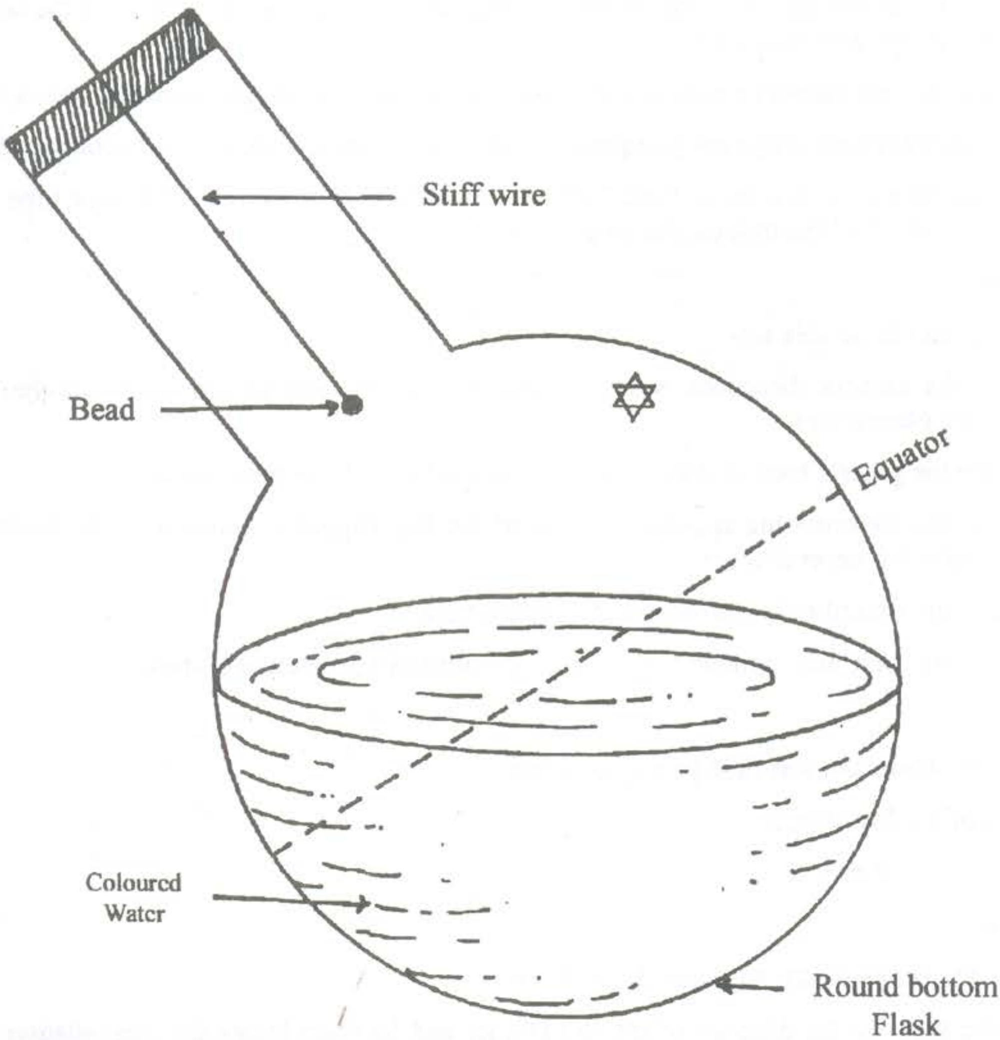


At North Pole

C



At the Equator


Stiff wire
Bead
Equator
Coloured
Water
Round bottom
Flask

TARAMANDAL PROGRAMME

Grade Level: IV - VI

Finding the Cardinal Points, the Polestar and Movements of the Celestial Bodies

Concepts to be developed

1. The celestial bodies move from east to west daily
2. The cardinal points are fixed directions with respect to which the movements of the celestial objects are seen and measured.
3. Stars and planets cannot be seen due to other stronger sources of light present in the sky.
4. The constellations are imaginary groupings of stars but the stars are not physically connected.
5. The celestial bodies also move from East to West slowly. If observed at the same time of the night over months, this motion can be detected.

Objectives

The students should be able to:-

1. Identify the cardinal directions within the planetarium and will be able to locate the North Star in the planetarium
2. Describe the general East to West movement of the Sun, Moon and the stars
3. Observe and describe the apparent motion of the Big Dipper in relation to the North Star over a period of several hours
4. Observe and describe the movement of constellations
5. Describe the daily and monthly East to West motions of the celestial bodies.

Materials

1. Standard set-up and star field projection drum
2. Sketch of the Big Dipper
3. Arrow torch - 4 nos.

Procedure

1. Divide the students into 4 groups (N, S, E, W)
2. Give the students the diagram of the Big Dipper and let them locate the constellation. Give the groups sufficient time and congratulate the group, which finds the Dipper first.
3. Let the students locate the pointer stars.
4. Tell the students to follow the imaginary line joining the two stars and to extend the length 5 times. A moderately bright star is seen there. Tell them that this is the Pole Star.
5. Tell the students to establish that this direction is North.
6. Now the students may find out South, East & West on their own.
7. Set the projector for 12o'clock midnight in the month of December. Let the students observe the constellation of Orion.
8. Turn the drum to the next hour setting and let the students observe the same constellation.
9. Repeat until Orion disappears and continues till it reappears.

10. Let the students observe the directional movement of the constellation. Point out that this is East-West direction.

11. Use the same procedure substituting months for hourly settings. Specify that monthly observation is to be made at the same time of night each month.

12. Let the students identify the Big Dipper. Set the projector for 8 P.M. and let the students observe the position of the Big Dipper.

13. Turn the projector for 9 P.M., 10 P.M. etc. Let the students note the positions of the Dipper. Suggest that the positions of the Dipper can be used for telling time.

14. Project the Dipper at 8 P.M. on different months and tell the students to note the change in position of the Dipper in different times of the year.

15. Show the Dipper positions at different latitudes through 24 hours and through the months. Show that the Dipper rises and sets at lower latitudes; while at higher latitudes it never sets. So, for lower latitudes, the Dipper cannot be used as a clock at night.

Note: The instructor may break the programme in two parts, if necessary, according to the standard of the students and available time.

TARAMANDAL PROGRAMME

Grade Level VI-VIII

Morning and Evening Star

Concepts to be developed

1. Morning and Evening Star is not a star it is the planet Venus.
2. Venus is very close to the Sun that is why it can be seen for a short time before and after sunrise and sunset.

Objectives

1. To help the students understand the difference between stars and planets.
2. To let the students find out that Venus is close to the Sun and cannot go beyond a certain angular distance from the Sun.

Requirements

1. Starfield cylinder
2. Venus projector
3. Star map of the month for which the sky is projected.

Procedure

Before the students enter the dome fix the starfield cylinder and set the sky for any month. Open the Sun stopper for the month so that the Sun shines in the western horizon. Open the Sun stopper for the next month and fix Venus projector and let the planet shine on the dome about 15 degrees to the East of the Sun. Keep the side lights on so that the dome remains fairly illuminated simulating the evening sky with sun close to the horizon and Venus a little above it. Turn off the projection lamp and let the students enter the dome.

After the preliminary introduction ask the students if they know about Morning and Evening star. Ask them if they have ever seen the star. Now turn on the projection lamp (keeping the side lamps on) and ask them how many stars they can see. The students will see a few bright stars and they will not miss the Evening Star. Now give the cylinder a slow motion and let the Sun just set below the horizon and dim the side lamps. Ask the students to mark the position of the evening star on the map as exactly as possible.

Now switch off the projection lamp and the side lights and shift the position of Venus a few degrees towards the East and again show the Sunset and ask the students if they find any change in its position. They will detect a shift. Ask them if there is any shift in the position of other stars relative to each other. There is no such shift. Let the students take a number of readings with different positions of the evening star. Never move Venus beyond 45 degree from the Sun towards the East. Now ask the students what they think of the 'Evening Star'. Explain that it is the planet Venus. The planets move against the background of stars and it can be seen by keeping a watch for a few nights. Bring the planet close to the Sun gradually and let the students plot its course. Ask the students why it did not go all the way round the sky. Venus is close to the Sun and cannot move very far off. Tell them that planets Mercury and Venus are called inferior planets. Their orbits lie between the Sun and the orbit of the Earth.

Similarly show the Morning Star. In this case place the planet projector at the Sun position one month WEST so that Venus rises before the Sunrise you want to show.

TARAMANDAL PROGRAMME

Grade Level VI - X

Moon's path - the month

Concepts to be developed

1. The Moon moves against the stellar background along a definite path which is close to the Sun's path - the Zodiac
2. The interval between two successive Full Moons or New Moons is the month.

Objectives

1. To make the students understand that the Moon's path is very close to the Sun's.
2. To find out that the moon moves very quickly against the stellar background.
3. To make the students observe that on a Full Moon day the Moon rises when the Sun sets.
4. To help the students calculate the length of the month.

Requirements

1. Starfield projection cylinder
2. Moon phase discs
3. Star map (6 months apart)

Procedure

Before the students enter the TARAMANDAL, the programme presenter should make the following arrangements:

Open all the Sun stoppers and place the Moon phase discs on the cylinder in right order. There are 10 such discs. Two holes remain free one for the setting sun another for the Full Moon on the opposite side - six months apart. Bring the setting Sun to the Western horizon so that the first crescent remains above the Western horizon followed by increasing phases and Full Moon on the Eastern horizon. Block all the phases by easily removable sticking plaster except the first crescent. Switch off the projection lamp and switch on the side lights and let the students enter the TARAMANDAL. After the preliminaries ask them if they have seen the phases of the Moon. Ask them where do they expect to see a thin crescent after the New Moon.

Now project the setting Sun and the crescent Moon. Ask them how long it takes the Moon to set from this position. Tell them that this moon is two and a quarter day old after the New Moon. Let them mark the position of the Moon on the star map. Let them also draw its phase. Tell them two hours after the Sunset this Moon will set. Close the first crescent and ask them where they expect to see the Moon 2 days later. Let them point out the place on the sky.

Now open the 2nd crescent and let them mark its position on the star map and ask them after how many hours this Moon will set after Sunset. The students will say what they think. Close the 2nd crescent and open the 1st quarter and repeat the same procedure till you come to the Full Moon. The Full Moon, as the students will calculate, will occur 15 days after the New Moon. Let the students join the Moon positions on the map and they will see that it moves along a definite path. Tell them that the background constellations are Zodiacal constellations - the path of the Sun. The Moon keeps very close to the Sun's path (only about 5 degrees away).

Now ask them what do they think will be the number of days between the Full Moon and the New Moon. They will say 15 days. So from New Moon to New Moon it is about 30 days i.e. a month. The same is true from Full Moon to Full Moon. Show them some pictures of the Moon and diagram of the phases.

TARAMANDAL PROGRAMME Grade Level VI - X

Duration of Day and Night

Concepts to be developed

1. The length of the day and that of night is different in different times of the year.
2. The change in duration of day and night causes the seasons.
3. Due to tilt of the Earth's axis with respect to its plane of orbit the difference in duration of day and night happens.

Objectives

1. To let the students learn to make a comparative measurement of the duration of day and night in different times of the year.
2. To let them understand that inequality in the length of day and night causes the seasons.
3. To let them discover the real reason for the change in this duration - the tilt of the Earth's axis.

Requirements

1. Starfield cylinder
2. Stop watch / Centre second watch / Digital watch
3. Work sheet

Procedure

- Ask the students when the days are long and when they are short. The students will come up with proper answers. Ask them do the lengths of the day and night remain the same throughout all the summer months or through all the winter months? The students may not be quite sure about this. Tell them that they can find it out for themselves in the TARAMANDAL. Ask the students during which months they expect long days. They may answer April, May, June, July, August etc. Tell them we are going to try with April, June, August.

Open the Sun stopper for April and keep the Sun in the rising position. Tell them that to hasten the matter you are giving a quick uniform motion to the Sun. Ask them to start a stopwatch or to start counting the seconds on a watch the moment they see the Sun leave the horizon and stop counting when the Sun just disappears below the horizon in the West.

Now start the daily motion switch and let the students count the time for April, June, August and let them record their observations.

In the same way let them find out the times for November, December and January. The students can now compare and identify the month having longest and shortest days and the month having longest and shortest nights. They can be told that the seasons are caused by unequal days and nights.

Tell them the real reason for this inequality. The axis of the Earth is tilted with respect to the plane of its orbit and is the reason for seasons. As an exercise tell the students to suggest, what would have happened if the axis were not tilted and if more tilted? Do they know about any other planet whose axis is very much tilted? Can they suggest of what length the day and night would be in Autumn and Spring on Earth?

Data Sheet for Day and Night

Month	Duration of Day	Duration of Night	Month of Longest Day	Month of Longest Night

TARAMANDAL PROGRAMME — Grade Level VI - X

Seeing the same sky at different hours

Concepts to be developed

1. The sky seen during the evening on a particular date can be seen at a different hour on a different date.
2. The phenomenon is dependent on the position of the Sun in different signs.
3. After one year from a particular date and time the sky will be the same.

Objectives

1. The students will understand that a specific sky configuration can always be seen by varying the time and date of observation.
2. To make the students understand that the position of the Sun at different Zodiacal constellation makes the night sky different on different days.
3. The students will be made to understand that the sky they see on a particular day at a particular time will be exactly the same on the same date and at the same time every year.

Requirements

1. Star map of the month.

Procedure

1. Open the Sun stopper of the current month and let the Sun be in the setting position. Distribute the star maps and let the students study the map carefully. Turn the daily motion switch. Let the Sun set just below the horizon. Tell the students that this is the sky at sunset say 6 O'clock today. Ask them if they can see the same sky i.e. all the stars and constellations in the same position with respect to the horizon at the same time (i.e. at Sunset) one month later. The students will suggest different answers. Tell them that now you are going to show the position of the Sun after one month.
2. Open the Sun stopper for the next month and the students will see the Sun well up in the sky. Ask them if they will be able to see the sky with sun still shining bright. Let them plot the position of the Sun on the star map. Now tell them what time they think it is when the Sun is in this position. They will suggest whatever they think. Tell them that the position of this Sun is 30 degrees from the previous Sun position and how long do they think this Sun will take to set. Tell them that the Earth turns on its axis in 24 hours i.e. it turns 360 degrees in 24 hours so for turning through 30 degrees it takes 2 hours and Sunrise and Sunset and all the sky movement occur due to Earth's rotation.
3. The students will say that the time now is about 4 O'clock. Tell them that the sky they saw earlier seen at 6 O'clock can be seen at 4 O'clock next month. Now ask them what time they could see the same sky if they had watched one month before the current month.
4. Let them speculate and come forward with many answers. Now open the Sun stopper of the previous month and bring the Sun to the Western horizon. Let the students see the sky now and compare this with the map. They will find that the sky is different though it is the Sunset time for the previous month. Project the Sun of the current month and tell them that they saw the sky as it was on the map when Sun for the present month was on the horizon and the Sun of the previous month was 30 degrees away from the Sun of the current month. When the Sun the current month comes to the horizon the last month's Sun would have gone down 2 hours earlier, so it will be 6 O'clock + 2 hours i.e. at 8 O'clock the previous month the same sky was there. Ask the students what time they will be able to see this sky 15 days later. When they will see this sky again at Sunset?

TARAMANDAL PROGRAMME Grade Level - VI-VIII

Where the sun will rise and set in different seasons

Concepts to be developed

1. Though the Sun is seen rising in the East but the point of rise shifts through the seasons. The setting points also change.
2. This change is due to the motion of the Earth and the tilt of the earth's axis.

Objectives

1. To make the students understand that the Sun moves apparently in the North South direction in four seasons.
2. The duration of day and night varies with seasons.
3. The duration of day and night varies with the observer's position on the Earth.

Materials

1. Stickers
2. Standard TARAMANDAL setting with starfield cylinder.

Procedure

1. Explain to the students that the Sun light sometimes comes through the Northern window and sometimes through the Southern window.
2. Ask them in which seasons these events take place.

   [In answer the students will say that in winter Sunlight comes through the Southern window and in summer through the Northern window]

Note: This phenomena is observed between latitudes 23 degrees 28 minutes South and 23 degrees 28 minutes North latitudes. If the programme is conducted at latitudes higher than 23 N sunlight will never come through the Northern window.

3. Now ask the students where they saw the Sunrise on the day of the TARAMANDAL show. Tell them to put stickers at the places they expect the Sun to rise.
4. Now turn on the Sun and move it to show the Sunrise point.
5. Ask the students where they expect the Sun to rise from a week or a month later.
6. After the students have planted stickers turn on the Sun for that day.
7. Ask the students if there are any other date during the year when the Sun will rise and set in the same place as it did today.
8. Ask the students if they can tell on which dates the Sun will rise exactly in the East.
9. Repeat the procedure by asking the students about the Sunset points.
10. Tell the students to find out the duration of day and night by rotating the Sun through one complete cycle i.e. Sunrise to Sunrise. The Sun remains above the horizon - i.e. the day - for different length of time in summer, winter, autumn and spring.

TARAMANDAL PROGRAMME

Grade Level - VII - VIII

How the stars are named in different constellations

Concepts to be developed

1. In astronomy universal nomenclature is used to name the stars. This is necessary for identification, although some prominent stars have got proper names.
2. Objects having common characteristics can be grouped together. In the case of the stars, brightness is a common characteristic.
3. Greek alphabets are used to designate the brightness followed by Latin names of the stars in its possessive form. Example: Alpha Canis Majoris The brightest star in the constellation of Canis Major.

Objectives

1. The students will be able to name some stars in known constellations.
2. The students will be able to identify the constellation figures.
3. They will also be able, with a little practice, to identify the constellations by observing the bright stars in the real sky even when the dim stars of that constellations are not visible due to interfering factors like city lights, haze, etc.

Materials Required

1. Student Work sheets
2. Pen lights and pencils
3. Slide projector
4. Slides

Procedure

1. Distribute the work sheets and other materials
2. Turn down the side lights and show the stars at full brightness. Keep this on for sometime so that students may retain memories of the stars. Then turn on the side lights until all stars disappear.
3. Now gradually dim side lights until only the brightest stars can be seen. Continue further till a few more stars appear. The students must feel that this is done to aid in the differentiating between degrees of brightness.
4. Again show the star field at full brightness with all the constellation represented on the students' work sheets visible.
5. Ask the class to name the constellations and enter the names on their work sheets.
6. Turn on the side lights and then gradually dim them again. At each step ask the students to point out the newly appearing stars. The first star to appear will be alpha regardless of the constellation.
7. Turn off all stars and project on the dome a constellation slide. Let students point out to the stars in order of brightness and name them.

8. Repeat the above for all other constellations. By seeing the slides it may be difficult to differentiate the brightness. But if the slides are designed in such a fashion that the bright and dim stars are indicated, the students will be able to verify their findings.

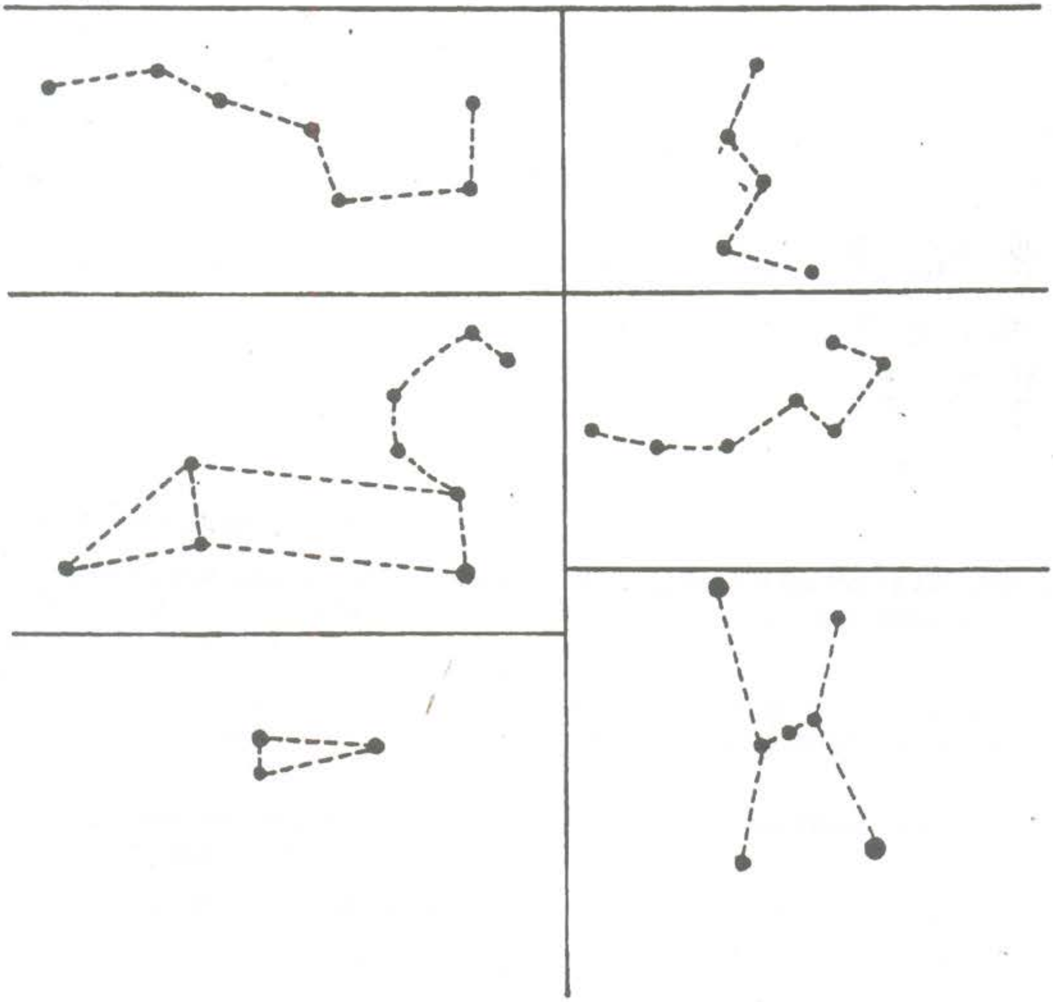
9. Project the Big Dipper and let the students point out how the stars are named and how they would be named in the Big Dipper.

10. Ask the students to suggest a system for naming stars if the number of stars in a constellation is more than the Greek alphabet. (Example: 61 Cygni)

STAR NOMENCLATURE WORKSHEETS

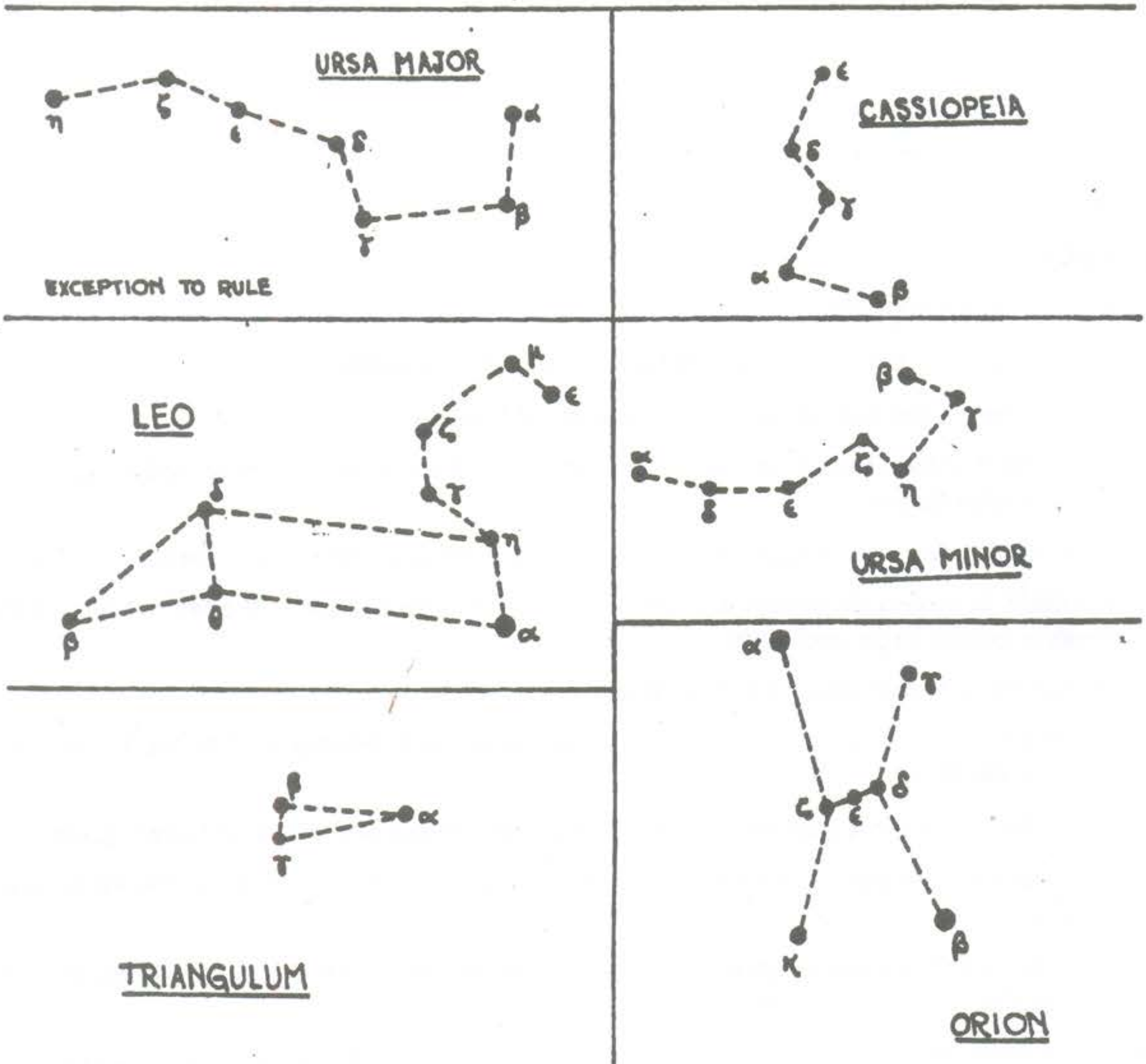
GREEK ALPHABET

ALPHA	α	ETA	η	NU	ν	TAU	τ
BETA	β	THETA	θ	XI	ξ	UPSILON	υ
GAMMA	γ	IOTA	ι	OMICRON	ο	PHI	φ
DELTA	δ	KAPPA	κ	PI	π	CHI	χ
EPSILON	ε	LAMBDA	λ	RHO	ρ	PSI	ψ
ZETA	ζ	MU	μ	SIGMA	σ	OMEGA	ω



STAR NOMENCLATURE STUDY SHEET
GREEK ALPHABET

ALPHA	α	ETA	η	NU	ν	TAU	τ
BETA	β	THETA	θ	XI	ξ	UPSILON	υ
GAMMA	γ	IOTA	ι	OMICRON	ο	PHI	φ
DELTA	δ	KAPPA	κ	PI	π	CHI	χ
EPSILON	ϵ	LAMBDA	λ	RHO	ρ	PSI	ψ
ZETA	ζ	MU	μ	SIGMA	σ	OMEGA	ω



TARAMANDAL PROGRAMME

Grade Level - VII-IX

Phases of the moon

Concepts to be developed

1. The Moon changes phases due to its position with respect to the Sun and the Earth.
2. The Moon is seen at different points in different phases at Sunset and Sunrise times.

Objectives

1. The students will be able to identify the phases of the Moon.
2. The students will be able to identify the waxing and the waning Moon by seeing its position in the sky with respect to the Sun and the orientation of the Moon's lighted sight.
3. The students will be able to predict the Moonrise time by seeing the phases.

Materials

1. The standard set up
2. 35mm slide projector
3. Moon phase slide set

Procedure

1. Begin with the New Moon.
2. Tell the students that the Sun and the Moon rise and set together.
3. Project the waxing crescent slide in its position at Sundown.
4. Point out that the Moon rose about 50 minutes after Sunrise and therefore, will set about 50 minutes after Sunset.
5. Make the students note that the horns are pointing away from the Sun i.e. towards the East.
6. Continue to project the phases in order. Emphasize that the portion of the Moon see from the Earth is getting larger each night.
7. At full Moon it rises about the same time the Sun sets.
8. Continue to show the waning phases of the Moon and emphasize that the horns point towards the West.
9. After showing the last crescent, tell the students that the Sun and Moon will rise together.
10. Now let the students tell where to project the phases as you run through the whole lunar month.
11. Now project the phases at random and ask the students to identify the phases of the moon by its shape and direction of horns.

Note: The direction of the Cusps (horn) gives important clues for identification of the phases.

TABLE OF MOON PHASE LOCATION OVER MONTH SCALE ON THE PROJECTOR

Sun Position	New	First Crescent		First Quarter	First Gibbous		Full Moon	Last Gibbous		Last Quarter	Last Crescent	
Jan	-	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feb	-	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Mar	-	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Apr	-	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
May	-	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Jun	-	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Jul	-	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Aug	-	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Sep	-	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Oct	-	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Nov	-	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Dec	-	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov

TARAMANDAL PROGRAMME Grade Level VII - X

Duration of day light at different latitudes in summer

Concepts to be developed

1. Sun remains in the day sky for longer time in summer the higher the latitude is.
2. At the North Pole it remains in the sky for 6 months through 24 hours.

Objectives

1. The students will be able to calculate roughly the duration of daylight in summer as one travels from Equator to North Pole.
2. To let the students find out that the night becomes shorter and shorter in summer as one travels north.
3. To let the students understand the reason for short days and long nights during Northern winter season.

Requirements

1. Stop watch or centre second watch
2. Data sheet for recording time and latitude.

Procedure

After preliminary introduction, ask the students if they have noticed that the days are longer and nights shorter in summer. Ask them to tell roughly what is the duration of day and night in the month of June at their hometown. Let them guess and let them record their estimate on the data sheet.

Now ask them what they would find if they were at the Equator. Let them come forward with answers. Tell the students that you can take them to the Equator and to the North Pole so that they can find it out for themselves. Now open the Sun stopper for June and keep the Sun at sunrise position. Tell the students that the Sun rises and sets because the Earth is moving on its axis in 24 hours.

If you count the time between one Sunrise and the next there will be 24 hours in it. In the TARAMANDAL a motor can hasten the daily motion. Ask the students to measure the time between Sunrise to the next Sunrise by their watch or by a stopwatch. This time may be considered as 24 hours in reality.

Turn on the daily motion switch and let the students count the minutes and seconds elapsed till the Sun comes to the next rising position. Let the interval represent 24 hours. Now bring the cylinder to the horizontal position and tell the students that the sky they will see now is for the equator.

Turn on the projection lamp and bring the Sun to the rising position. Tell the students to start counting time as soon as the Sun rises and they should stop counting as the Sun sets. Throw the daily motion switch on and let the students begin counting. Let them stop counting as soon as the Sun sets. Ask the students how many hours this time interval represents. The students can easily find out by proportion method. Now repeat the same procedure by setting the cylinder for 30 degree and 60 degree latitudes. Next, set the cylinder for North Pole and let the students mark the position of the Sun by a sticker. Let the daily motion on and tell them to start counting time. They should stop when the Sun comes back to the sticker.

Let them compare the day light times for different latitudes. They will find out the duration of real day from their observation from the times the Taramandal sun took to make one cycle. They will find that at North Pole there is 24 hours daylight.

Data Sheet for Latitude Vs Daylight

TARAMANDAL time from Sunrise to next Sunrise. Duration of day and night at home town

Latitude	Month	Length of day (Taramandal Time)	Actual time	Length of the Night (Taramandal Time)	Action time

TARAMANDAL PROGRAMME

Grade Level - VIII

How bright are the stars

Concept to be Developed

1. The stars are vary in brightness when seen from the earth. This is not the actual brightness, this is *APPARENT BRIGHTNESS*. (for a discussion on brightness, apparent and absolute magnitudes see annexure-II
2. Brightness is one important criterion for different stars.

Requirements

1. Brightness scaler
2. paper
3. pencil
4. pen
5. torch
6. star chart showing different magnitudes.

Procedure

1. After introducing the planetarium ask the students if they have observed that some stars are bright, some are dim. The students will reply that they have done so.
2. Ask them whether they have thought that the stars may be arranged according to the brightness and is it possible to know how many times one is brighter or dimmer than the other? (Tell them it is possible)
3. Switch on the lamp of the projector but not to the full brightness. Let some bright stars be visible on the planetarium dome.
4. Tell the students to identify them and give a cue if necessary. Let them study the brightness and colour of the stars.
5. Divide the students into groups of four or five and distribute the scaling equipment. Ask the students to examine the equipment and use it in devising a scale for magnitude.

   (The students should be told not to touch the cellophane as this will leave finger prints and obstruct viewing)
6. Tell them to devise a scale and apply the scale to classify the brightness of stars in different constellations like the Big Dipper, Orion, Pegasus, Taurus, Scorpio, etc.
7. Show the students some stars on the dome and ask them to rate these stars according to their scaler.
8. Discuss about the Stellar Magnitude both apparent and absolute. Give them the list of 20 bright stars in order of diminishing brightness and also their absolute magnitudes

STAR BRIGHTNESS COMPARATOR

Annexure-I

Concepts to be developed

All stars do not look equally bright. As viewed from Earth, stars display different degrees of brightness. The brightness we see is not the actual brightness, it is an apparent brightness.

Objective

With the aid of a simple Brightness Comparator, the student will be able to formulate a scale of apparent brightness for the stars.

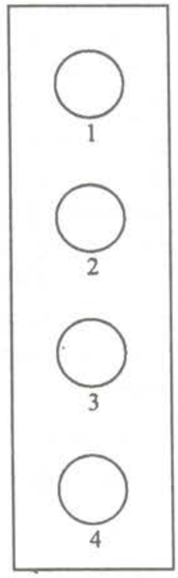
Materials

Cardboard (10" x 2")

Clear cellophane or plastic wrap

Scissors

Adhesive tape



Set Up and Conduct your activity

Use the diagram as a guide

1. Punch out 4 holes on the cardboard
2. Number each hole 1 through 4
3. Cut strips of cellophane so that No.1 hole will be covered by one strip and No.2 hole by two strips and so on
4. Tape the strips onto the cardboard

Use

To use your Brightness Comparator: Observe a star through a numbered opening. Through the highest numbered opening you are able to observe a star that indicates the highest apparent magnitude of the star.

Number of opening	Magnitude of star
1	5
2	4
3	3
4	2

Note: Start with the highest numbered hole (4)

A note on the stellar magnitude for the planetarium educators Annexure-II

Stars differ in brightness. Astronomers classify the brightness of stars in terms of magnitudes. The brightest stars are of first magnitude, the less bright ones are of second magnitude etc. The larger the number, the fainter the star. With the naked eye we can see stars upto 6th magnitude. Higher magnitude than the 6th are too faint to see with the naked eye.

A first magnitude star is 2.5 times brighter than a second magnitude star and a second magnitude star is again 2.5 times brighter than a third magnitude star and so on. A first magnitude star is 100 times brighter than a 6th magnitude star.

If a star is 2.5 times brighter than the 1st magnitude star its magnitude is 0 and stars having more brightness than 0 is designated by negative magnitudes. For example, the apparent magnitude of the Sun is -27 and the star Sirius has a brightness -1.6. This is called Apparent magnitude as this is just what we see from the earth.

A star may appear bright for two reasons. (1) It may be very near as the Sun is or it may be intrinsically very bright. As an example it may be noticed that if two lamps, one very bright and the other dim are so placed that the brighter one is far off, they will seem to have equal brightness from a certain point. They have the same apparent magnitude but different absolute magnitude. Some stars may be very dim because of their distance from the earth but actually they may be very bright i.e. their absolute magnitudes are high.

The absolute magnitudes are determined by imagining the stars placed at a definite distance and calculating the luminosities they would have if viewed from the earth. The standard distance is 10 parsecs or 32.6 light years.

20 Bright Stars

	Name of the Star	Constellation	Apparent Magnitude	Absolute Magnitude
1	Sirius	Canis Major	-1.46	+1.4
2	Canopus	Carina	-0.72	-3.1
3	Arcturus	Bootes	+0.01	-0.3
4	Alpha Centauri	Centaurus	-0.06	+4.4
5	Vega	Lyra	+0.04	+0.5
6	Capella	Auriga	+0.05	-0.7
7	Rigel	Orion	+0.14	-6.8
8	Procyon	Canis Minor	+0.38	+2.8
9	Betelgeuse	Orion	+0.51	-2.3
10	Achernar	Eridanus	+0.41	-5.6
11	Agena	Centaurus	+0.61	-5.2
12	Altair	Aquila	+0.77	+2.2
13	Aldebaran	Taurus	0.85	-0.7
14	Antares	Scorpio	0.96	-5.1
15	Spica	Virgo	0.98	-3.3
16	Pollux	Gemini	1.14	+1.0
17	Fomalhaut	Piscis Australis	1.16	+2.0
18	Deneb	Cygnus	1.25	-7.1
19	Regulus	Leo	1.35	-0.7
20	Beta Cucis	Crux	1.28	-4.6

TARAMANDAL PROGRAMME

Grade Level: VIII to X

Star Hunt

Objectives:

1. Introducing students to the night sky.
2. Learning how to locate the North Star and to find directions using the stars.
3. Reading a star chart
4. Finding Constellations

Requirements

1. Star maps for the month
2. Pointer Torches
3. Pencil Torches (for aiding map reading etc.)
4. Clip boards (for providing hard surface to place the maps)
5. Slide Projector
6. Appropriate slides
7. Mirror with movable mounting

Procedure

1. Introduction and explanation of the portable planetarium and star projector. This will help the students to adapt to the darkness of the dome.
2. Ask the students - What is the most well known star with a peculiarity in the Northern Hemisphere? (The students will come up with different answers, like Sirius, Aldebaran etc: The answer is the pole star. But every answer should be accepted. If anyone suggests the pole star give him full credit).
3. Ask the students what is peculiar about the North or Pole Star.
4. Give the students a chance to locate the Pole Star. (It is strange that most, almost everyone will come up with wrong answer).
5. Ask the students for the reason of their choosing a particular star as the North Star.
   a) Location on the sky?
   b) Brightness?
   c) Colour?
   (Everyone will offer some reason or the other)
6. Tell the students that North Star is not at all a bright star. In fact, it is a faint star barely visible from a city. It is listed as 53rd in order of brightness.
7. It is not easy to find the North Star, unless one knows some clue. That clue is the Big Dipper, or the Ursa Major or as known in India, Saptarshi Mandal.
   Ask the students if they find the Big Dipper which is shaped like a question mark (?) or a ladle consisting of seven stars.
   (At this point a slide may be projected which shows the out line of the big dipper, whose pointers are joined to show the direction of the Pole Star)
   The students by now will be able to find the North Star.

8. Use the Dipper pointers, extend the distance 5 times to arrive at the North Star.

9. Now that the North is found out which direction are South, East & West? Put stickers marked N S E W on the dome.

10. Deal out star maps and ask the students to hold their maps so that the directions (North, South etc.) correspond to the cardinal points given on the map.

    (The students will find that the directions North and South of the dome will agree with those of the map. But East and West points have interchanged. Ask the students to try out various means to make the directions coincide. Some may hit the mark or may not. Now tell them that when they read a road map which shows the surface of the Earth they hold the map as they read a book. When reading a star map they must hold it in the same way as they look at the sky that is the map must be held above their heads and now the directions coincide exactly!)

11. Define Horizon or Zenith on the star chart and on the planetarium Dome.

    (In the planetarium, the zenith is the point just vertically above the projector which is kept at the centre of the dome. On the star chart the zenith is the centre of the circle and the circle is the horizon. In observing the sky the zenith is the point exactly overhead of the observer. Thus the zenith varies with the location of the observer on the surface of the earth. Since the planetarium dome is very small, the zenith for the students will lie near the horizon. By imagining that they are sitting under a real sky the zenith will be the zenith of the dome. The horizon is the horizontal line along the inner surface of the dome which marks the rising and setting points of the stars. To show the horizon (if required) take out the projection cylinder and turn on the projection lamp. The dome will be lighted up and the horizon will be seen as a line separating the lighted portion from a dark shadow near the base of the dome).

12. Tell the students about constellations which are patterns obtained by joining some stars by imaginary lines.

13. Assign each group a particular constellation which they will identify on the dome by consulting the star chart. (Divide the students into 4 groups. It is preferable to select the students who are sitting in North East, North West, South East & South West directions. Assign such constellations to each group which lie approximately the opposite side i.e. to the N.E group assign a constellation on the South West side and so on. This is done because the students need not strain their neck in searching out the constellations assigned to them from the crowd of other stars.)

14. Ask each group to identify the constellations assigned to them (each group should be given a pointer torch for searching). What familiar objects these constellations resemble? Give them time and guidance. Tell the students to find out approximate location of the constellation in the Star Chart i.e. whether it is near the horizon or near the zenith. This will help them in locating the constellation on the dome.

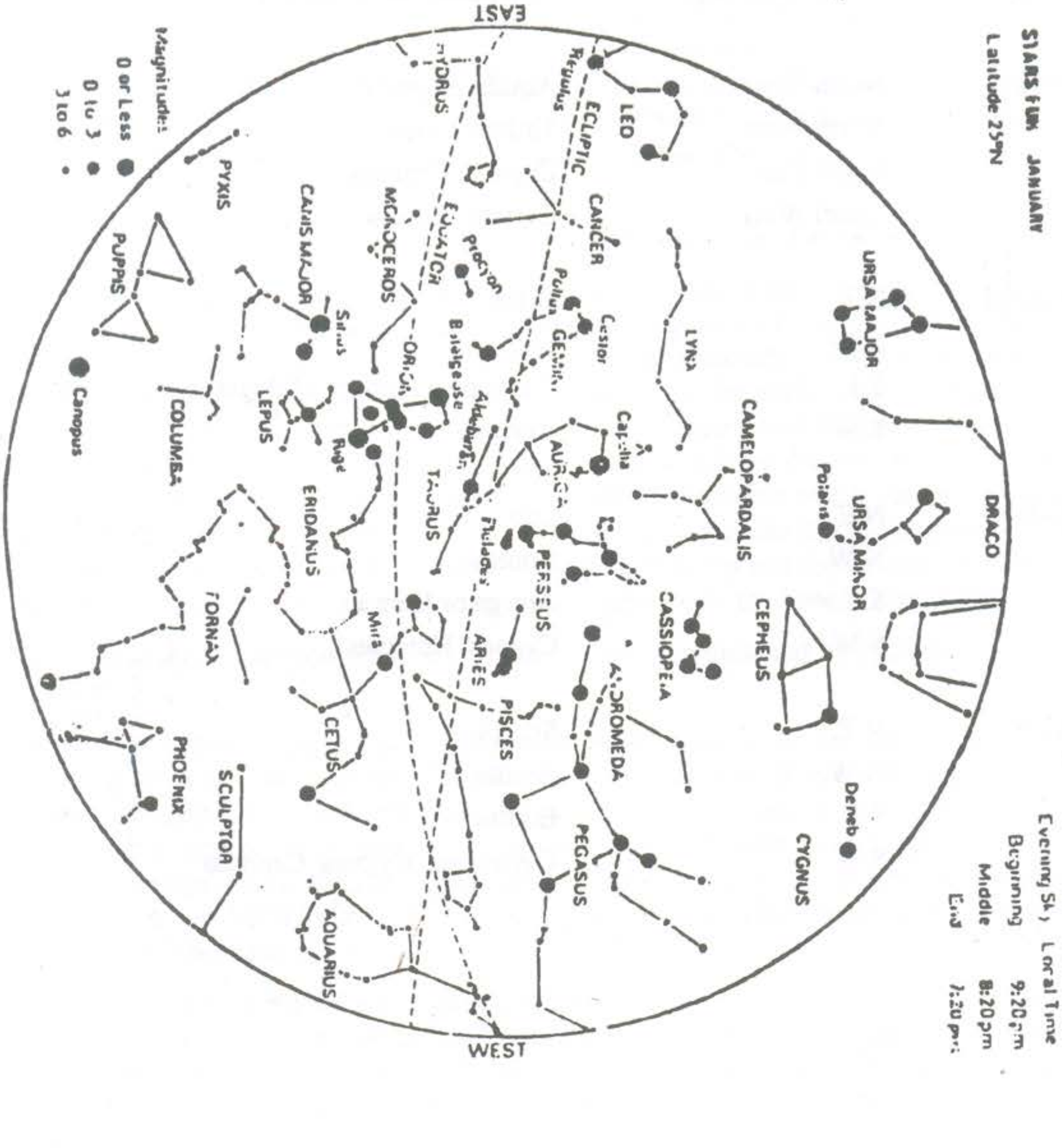
15. When they have located the assigned constellations, ask them to show these to other groups.

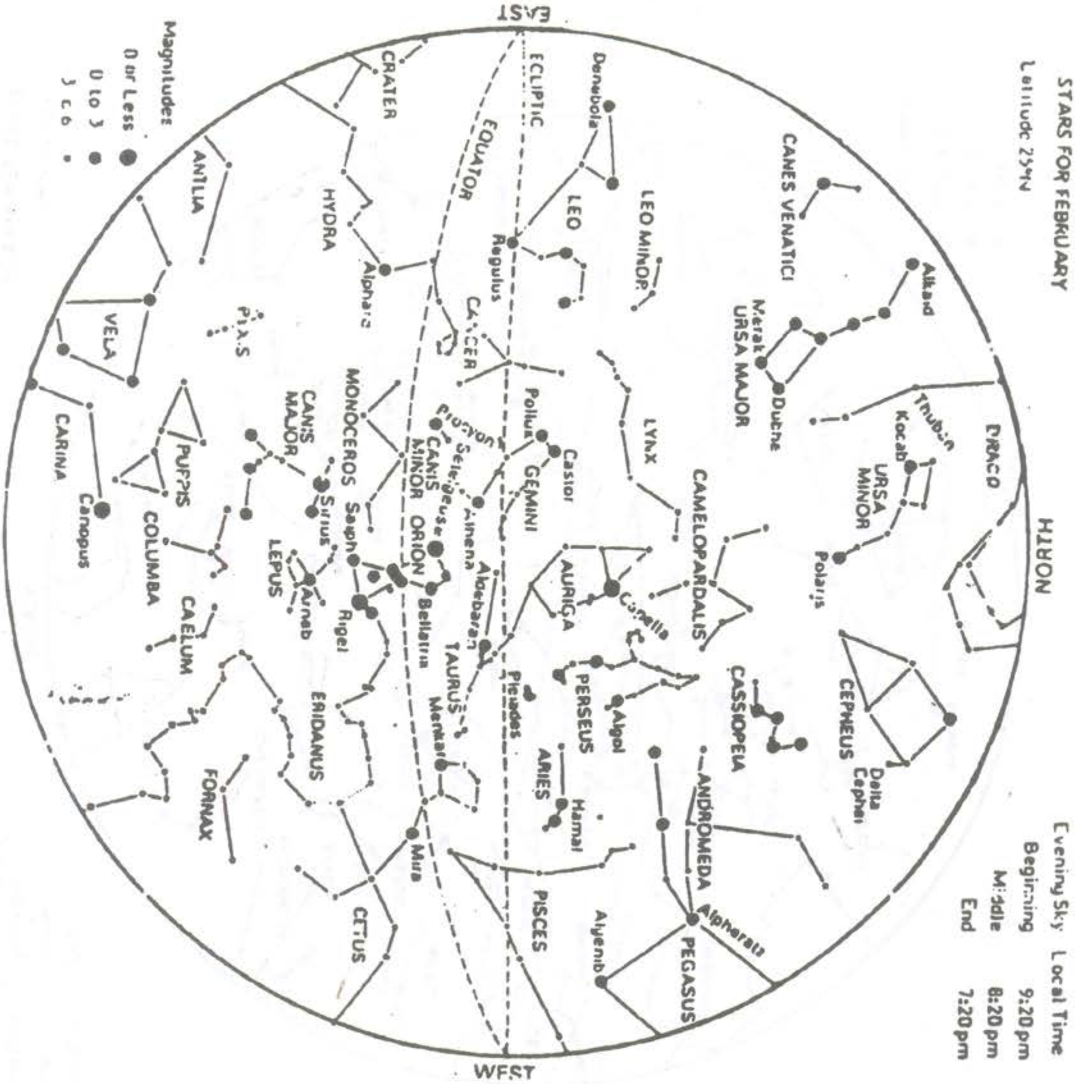
    The lecturer adds interesting information like star legends, constellation legends, slides of the objects pertaining to the constellation discussed.

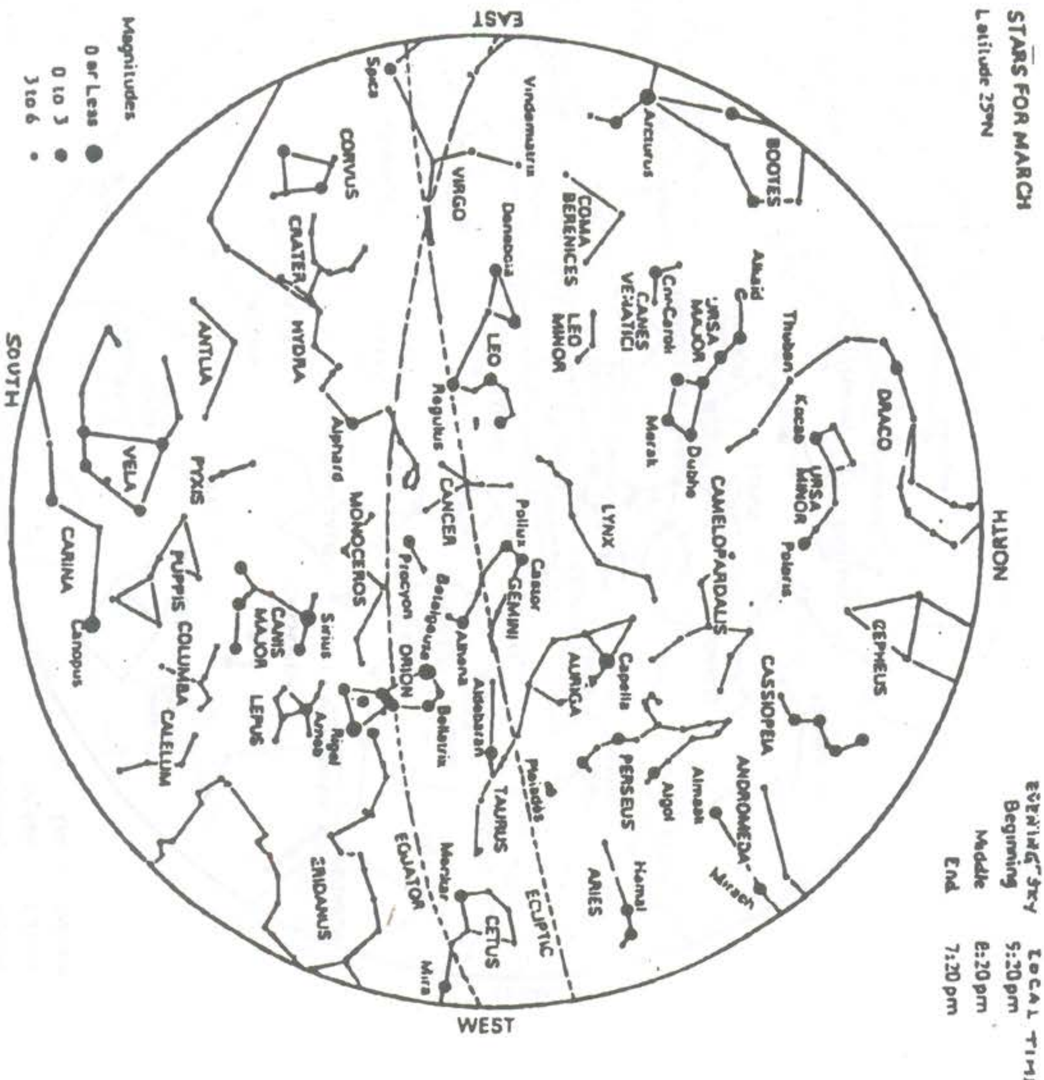
16. Switch off the projector lamp and let the cylinder move for a little while. Brighten the projector lamp. The constellations have shifted position. But the Pole Star is fixed.

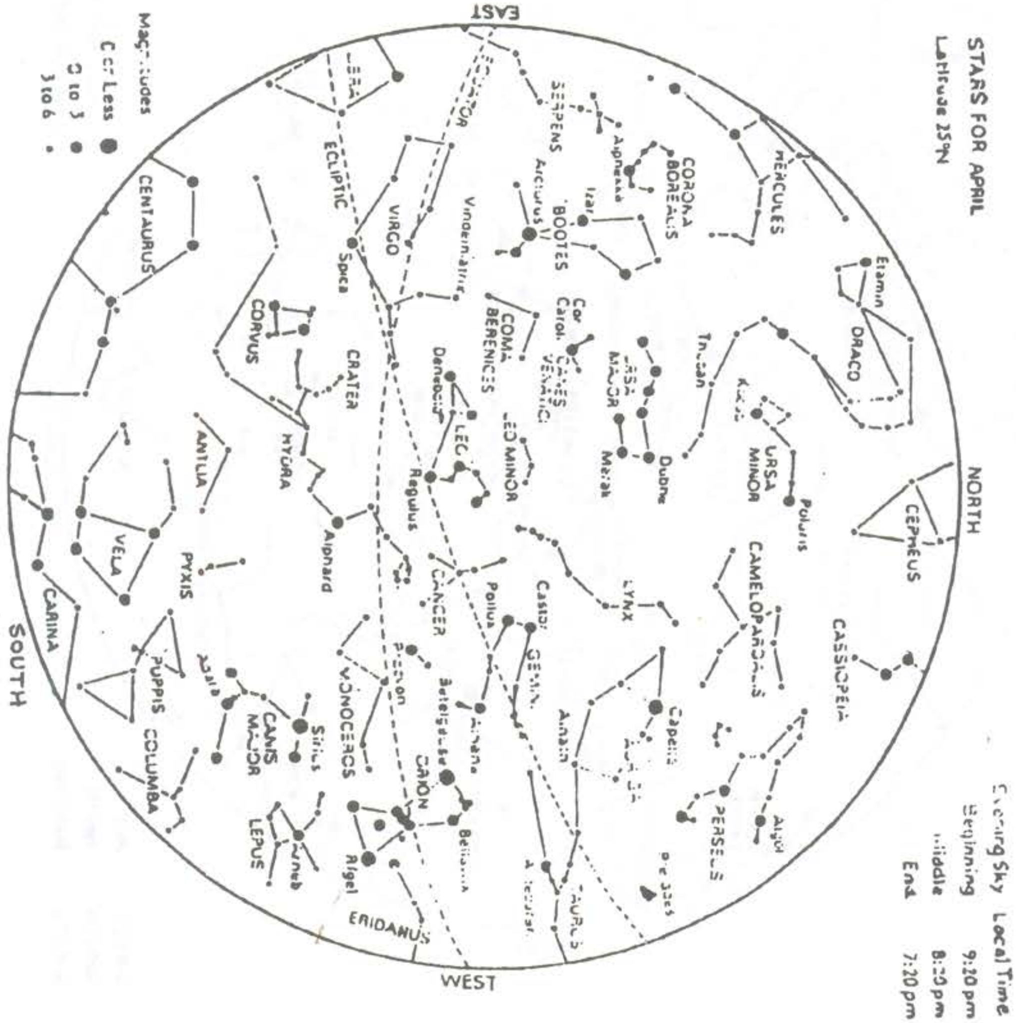
    The following table will be helpful to choose the Constellations for different groups at different times of the year.

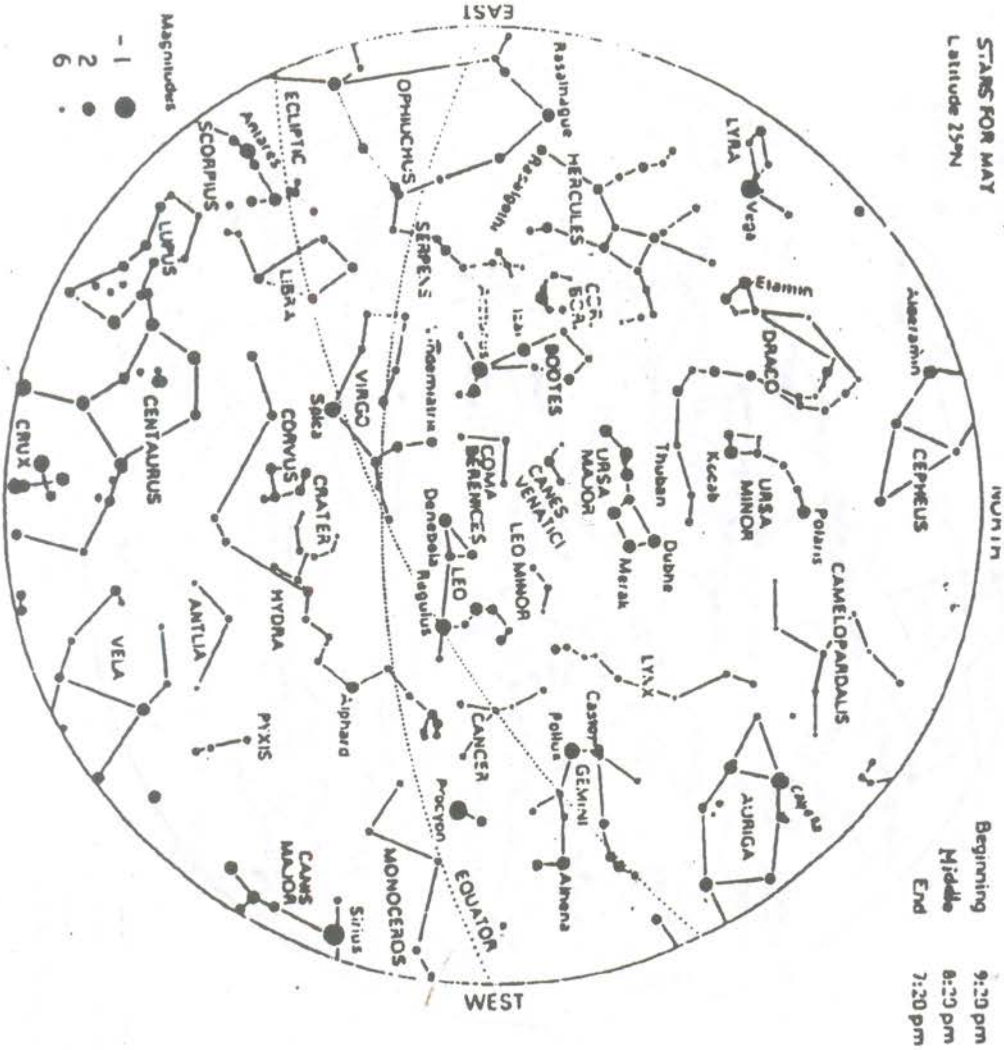
Month	Student Group	Constellation Assigned
Nov-Jan	North East	Aquila, Pegasus
	North West	Taurus, Orion
	South East	Cygnus, Cepheus
	South West	Gemini, Auriga
Feb-April	N.E.	Orion
	N.W.	Leo
	S.E.	Cassiopeia, Square of Pegasus
	S.W.	Auriga
May-July	N.E.	Leo
	N.W.	Bootes
	S.E.	Auriga or Gemini
	S.W.	Cygnus, Hercules
Aug-Oct	N.E.	Scorpio
	N.W.	Aquila
	S.E.	Bootes
	S.W.	Cassiopeia, Cygnus, Cepheus

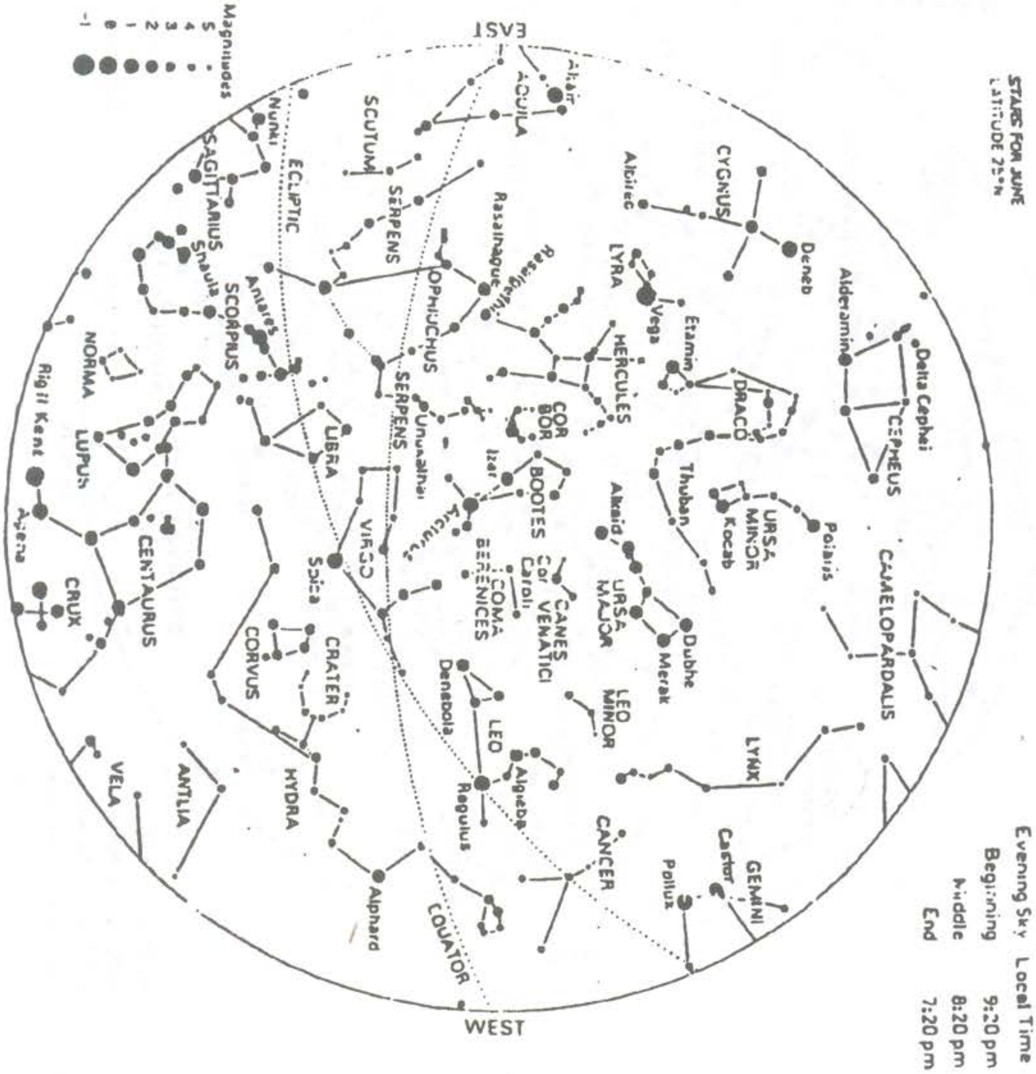

STARS FOR JANUARY
Latitude 25°N
Evening Sky Local Time
Beginning 9:20 pm
Middle 8:20 pm
Magnitudes:
0 or Less
0 to 3
3 to 6
EAST
WEST
ECLIPTIC
EQUATOR
LEO
Regulus
CANCER
URSA MAJOR
LYNX
Castor
Pollux
GEMINI
Procyon
MONOCEROS
CANIS MAJOR
Sirius
PYXIS
PUPPIS
Canopus
COLUMBA
LEPUS
Rigel
ORION
Betelgeuse
Aldebaran
TAURUS
AURIGA
Capella
CAMELOPARDALIS
Polaris
URSA MINOR
DRACO
CEPHEUS
CASSIOPEIA
PERSEUS
ERIDANUS
FORNAX
Mira
ARIES
PISCES
ANDROMEDA
CETUS
SCULPTOR
PHOENIX
PEGASUS
AQUARIUS
Deneb
CYGNUS

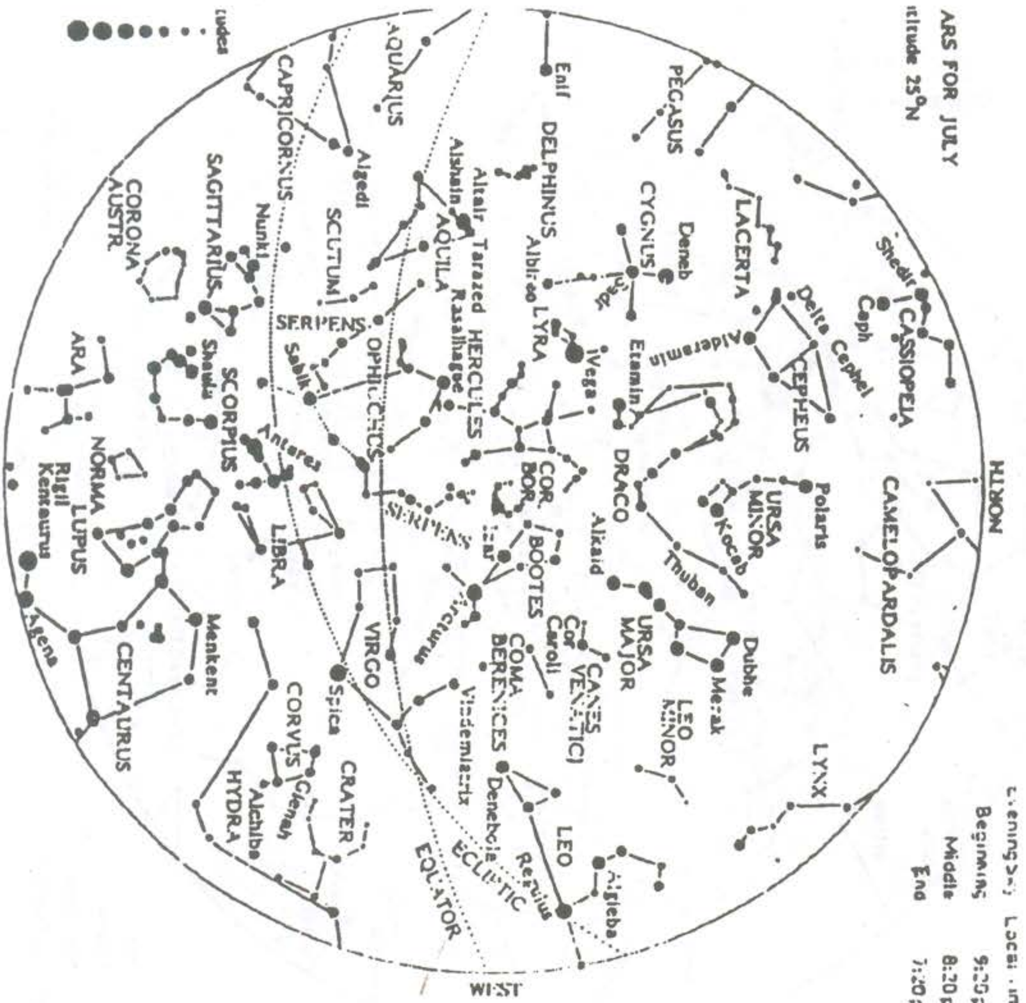

STARS FOR FEBRUARY
Evening Sky Local Time
Beginning 9:20pm
Middle 8:20pm
End 7:20pm
Magnitudes
0 or Less
0 to 3
3 to 6
NORTH
EAST
WEST
ECLIPTIC
EQUATOR
CANES VENATICI
URSA MAJOR
DRACO
URSA MINOR
Polaris
CEPHEUS
CASSIOPEIA
CAMELOPARDALIS
LYNX
LEO MINOR
LEO
Regulus
Denebola
CRATER
HYDRA
Alphard
ANTLIA
VELA
CARINA
Canopus
PUPPIS
COLUMBA
CAELUM
LEPUS
CANIS MAJOR
Sirius
MONOCEROS
CANIS MINOR
Procyon
GEMINI
Castor
Pollux
ORION
Rigel
Bellatrix
Betelgeuse
AURIGA
Capella
TAURUS
Aldebaran
Pleiades
PERSEUS
Algol
ARIES
Hamal
ANDROMEDA
Alpheratz
PEGASUS
Algenib
PISCES
CETUS
Mira
Menkar
ERIDANUS
FORNAX

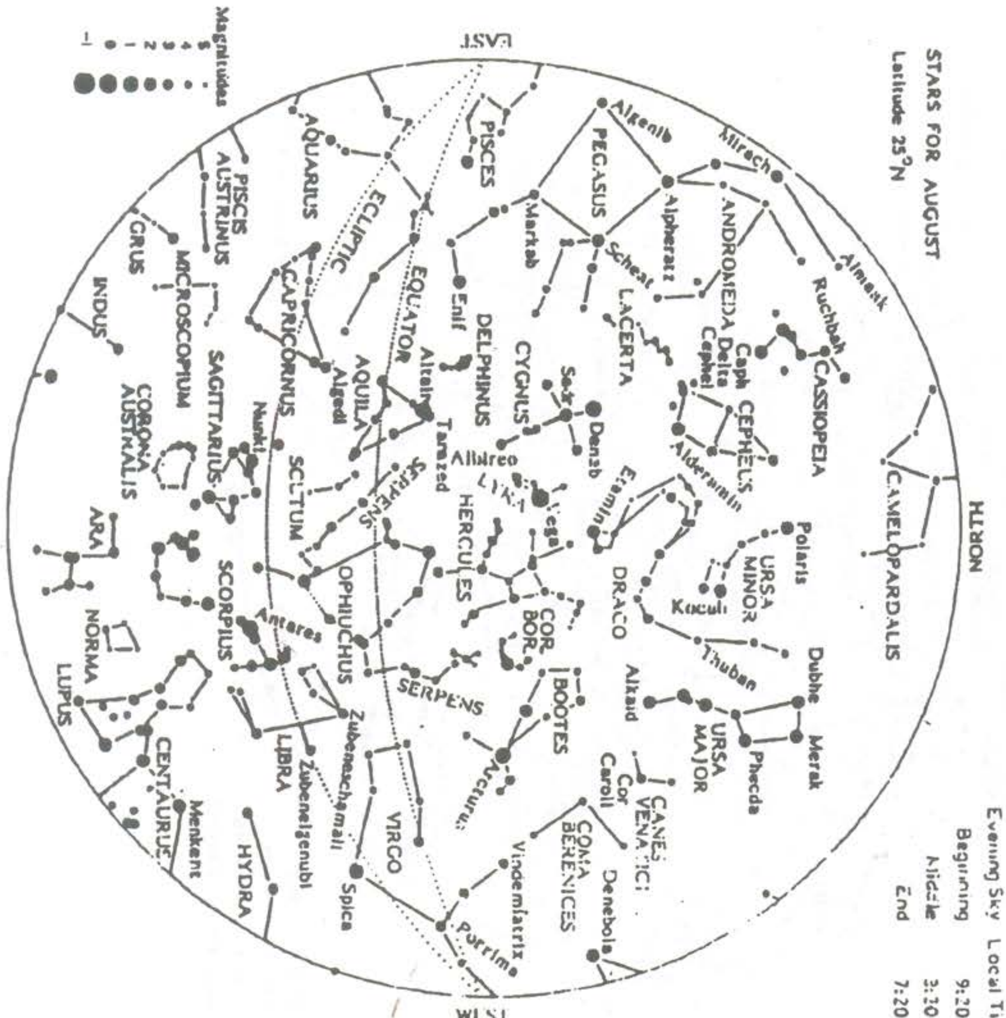

STARS FOR MARCH
Latitude 25°N
EVENING SKY LOCAL TIME
Beginning 5:20 pm
Middle 6:20 pm
End 7:20 pm
Magnitudes
0 or Less
0 to 3
3 to 6
NORTH
SOUTH
EAST
WEST
DRACO
Thuban
Kocab
URSA MINOR
Polaris
CEPHEUS
CASSIOPEIA
ANDROMEDA
Mirach
Almaak
Algol
PERSEUS
Hamal
ARIES
CETUS
Mira
Menkar
ECLIPTIC
EQUATOR
ERIDANUS
TAURUS
Pleiades
Aldebaran
Bellatrix
Rigel
ORION
Betelgeuse
Alnath
AURIGA
Capella
CAMELOPARDALIS
LYNX
GEMINI
Castor
Pollux
Procyon
CANCER
MONOCEROS
Sirius
CANIS MAJOR
LEPUS
Arneb
COLUMBA
CAELUM
PUPPIS
Canopus
CARINA
VELA
PYXIS
ANTLIA
HYDRA
Alphard
Regulus
LEO
LEO MINOR
Denebola
CRATER
CORVUS
VIRGO
Spica
Vindemiatrix
COMA BERENICES
CANES VENATICI
Cor Caroli
URSA MAJOR
Merak
Dubhe
Alkaid
BOOTES
Arcturus

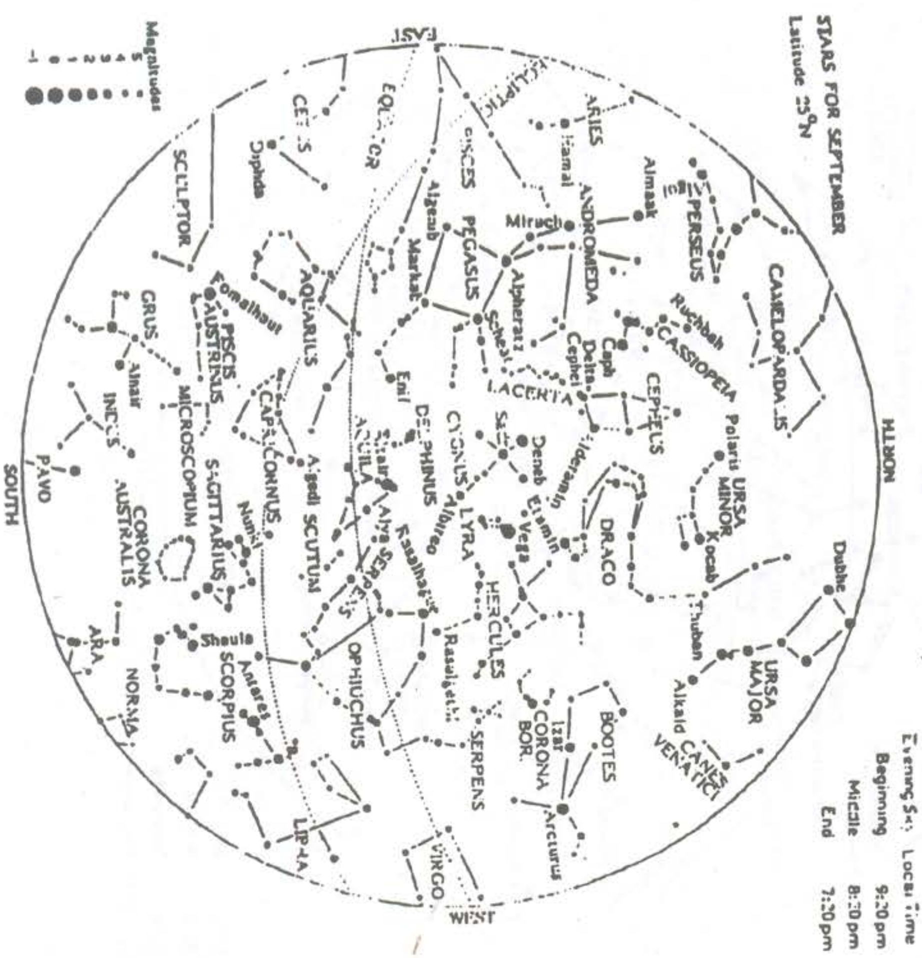

STARS FOR APRIL
Latitude 25°N
Local Time
9:20 pm
7:20 pm
NORTH
SOUTH
EAST
WEST
CEPHEUS
CASSIOPEIA
Etamin
DRACO
Polaris
URSA MINOR
CAMELOPARDALIS
Algol
PERSEUS
HERCULES
CORONA BOREALIS
Dubhe
URSA MAJOR
Merak
Capella
LYNX
SERPENS
BOOTES
Arcturus
Cor Caroli
CANES VENATICI
COMA BERENICES
LEO MINOR
Castor
GEMINI
Pollux
ECLIPTIC
Vindemiatrix
Denebola
LEO
Regulus
CANCER
Betelgeuse
ORION
VIRGO
Spica
CRATER
Procyon
MONOCEROS
Rigel
ERIDANUS
Alphard
HYDRA
CORVUS
Sirius
CANIS MAJOR
LEPUS
ANTLIA
PYXIS
PUPPIS
COLUMBA
CENTAURUS
VELA
CARINA
3 to 6

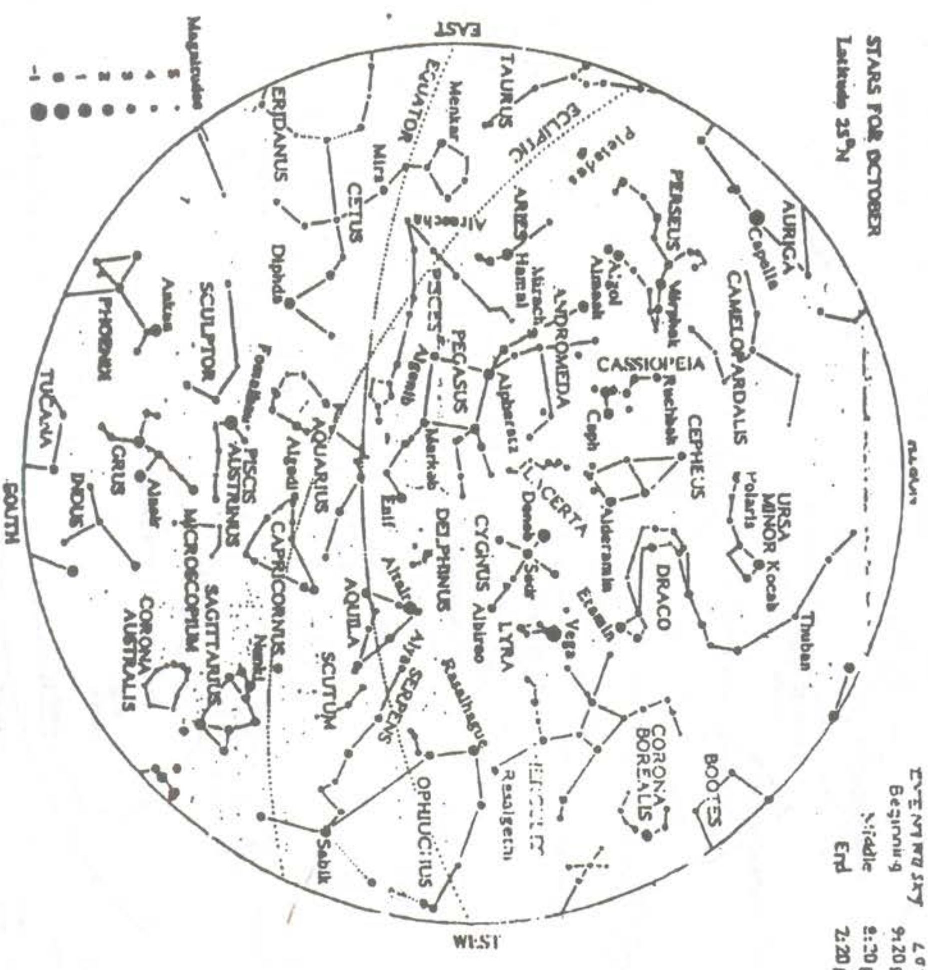

STARS FOR MAY
Latitude 25°N
Beginning 9:20 pm
Middle 8:20 pm
End 7:20 pm
EAST
WEST
NORTH
Magnitudes
-1
2
6
ECLIPTIC
EQUATOR
LYRA
Vega
HERCULES
Rasalhague
OPHIUCHUS
SERPENS
SCORPIUS
Antares
LUPUS
LIBRA
CORONA BOREALIS
BOOTES
Arcturus
DRACO
Eltanin
Thuban
CEPHEUS
URSA MINOR
Kocab
Polaris
URSA MAJOR
Dubhe
Merak
CAMELOPARDALIS
CANES VENATICI
COMA BERENICES
LEO MINOR
LEO
Denebola
Regulus
VIRGO
Spica
CORVUS
CRATER
CENTAURUS
CRUX
HYDRA
Alphard
ANTLIA
VELA
PYXIS
LYNX
AURIGA
Capella
GEMINI
Castor
Pollux
Alhena
CANCER
Procyon
MONOCEROS
CANIS MAJOR
Sirius

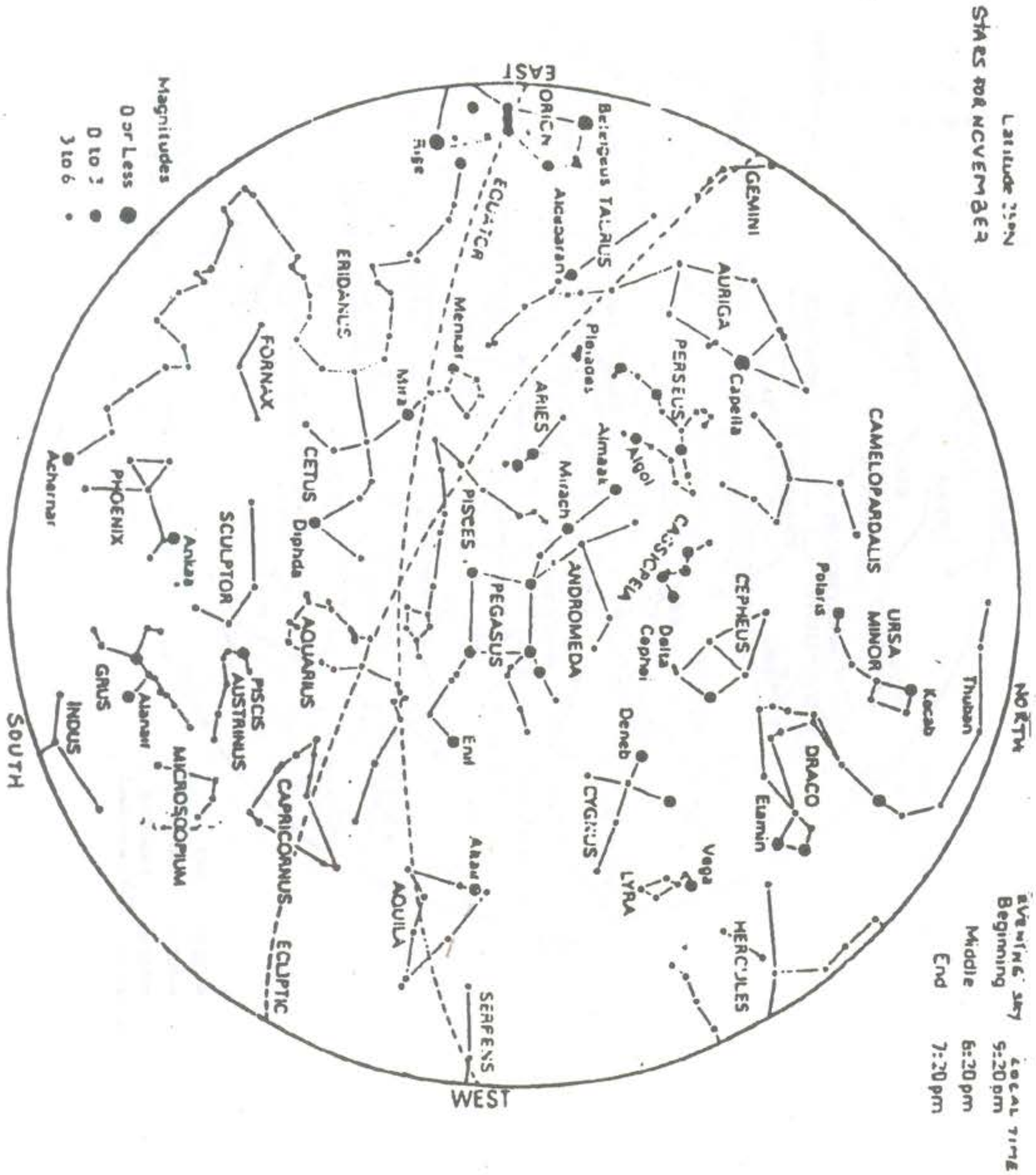

STARS FOR JUNE
LATITUDE 25°N
Evening Sky Local Time
Beginning 9:20 pm
Middle 8:20 pm
End 7:20 pm
Magnitudes
EAST
WEST
ECLIPTIC
EQUATOR
AQUILA
Altair
SCUTUM
SERPENS
CYGNUS
Deneb
Albireo
LYRA
Vega
Rasalhague
OPHIUCHUS
HERCULES
DRACO
Etamin
Thuban
CEPHEUS
Alderamin
Delta Cephei
URSA MINOR
Kocab
Polaris
CAMELOPARDALIS
SAGITTARIUS
Nunki
Shaula
SCORPIUS
Antares
LIBRA
COR BOR
BOOTES
Izar
Arcturus
Unukalhai
VIRGO
Spica
COMA BERENICES
CANES VENATICI
Cor Caroli
URSA MAJOR
Alkaid
Dubhe
Merak
LEO MINOR
LYNX
GEMINI
Castor
Pollux
CANCER
LEO
Denebola
Algieba
Regulus
CRATER
CORVUS
HYDRA
Alphard
ANTLIA
VELA
NORMA
LUPUS
CENTAURUS
CRUX
Rigil Kent
Agena

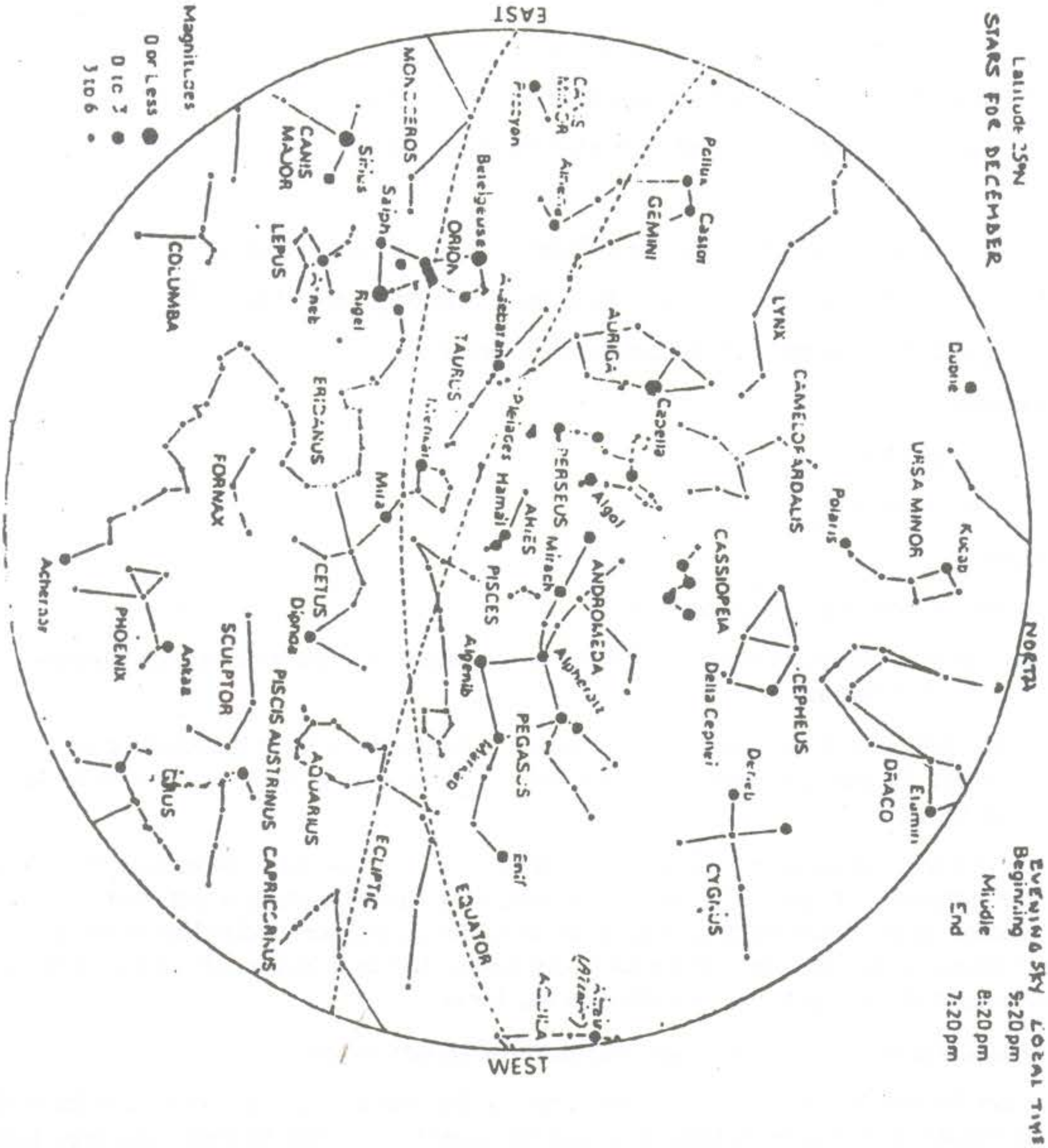

ARS FOR JULY
titude 25°N
NORTH
WEST
Evening Sky Local Time
Beginning 9:30pm
Middle 8:30pm
End 7:30pm
CASSIOPEIA
CAMELOPARDALIS
CEPHEUS
LYNX
URSA MINOR
Polaris
Kocab
DRACO
Thuban
URSA MAJOR
Dubhe
Merak
LEO MINOR
LEO
Regulus
CANES VENATICI
Cor Caroli
COMA BERENICES
Denebola
BOOTES
Arcturus
COR. BOR.
HERCULES
Rasalhague
LYRA
Vega
CYGNUS
Deneb
LACERTA
PEGASUS
Enif
DELPHINUS
AQUILA
Altair
Tarazed
Alshain
SCUTUM
SERPENS
OPHIUCHUS
Sabik
AQUARIUS
CAPRICORNUS
Algedi
SAGITTARIUS
Nunki
CORONA AUSTR.
SCORPIUS
Shaula
Antares
LIBRA
ARA
NORMA
LUPUS
Rigil Kentaurus
CENTAURUS
Menkent
VIRGO
Spica
CORVUS
Gienah
Algebra
CRATER
HYDRA
Alkaid
Etamin
Alderamin
Delta Cephei
Caph
Shedir
ECLIPTIC
EQUATOR


STARS FOR AUGUST
Latitude 25°N
Evening Sky Local Time
Beginning 9:20 pm.
Middle 8:30 pm
End 7:20 pm
NORTH
EAST
WEST
Magnitudes
CAMELOPARDALIS
CASSIOPEIA
Almaak
Mirach
Ruchbah
Caph
CEPHEUS
Delta Cephei
Alderamin
ANDROMEDA
Alpheratz
Algenib
PEGASUS
Scheat
Markab
LACERTA
PISCES
AQUARIUS
ECLIPTIC
EQUATOR
Enif
DELPHINUS
CYGNUS
Sadr
Deneb
Albireo
LYRA
Vega
Etamin
DRACO
Polaris
URSA MINOR
Kocab
Thuban
Dubhe
Merak
Phecda
URSA MAJOR
Alkaid
CANES VENATICI
Cor Caroli
COMA BERENICES
Denebola
Vindemiatrix
Porrima
Spica
VIRGO
BOOTES
Arcturus
COR. BOR.
HERCULES
SERPENS
OPHIUCHUS
AQUILA
Altair
Tarazed
Algedi
CAPRICORNUS
SCUTUM
SAGITTARIUS
Nunki
CORONA AUSTRALIS
MICROSCOPIUM
PISCIS AUSTRINUS
GRUS
INDUS
ARA
SCORPIUS
Antares
NORMA
LUPUS
CENTAURUS
Menkent
LIBRA
Zubeneschamali
Zubenelgenubi
HYDRA


STARS FOR SEPTEMBER
Latitude 25°N
Evening Sky Local Time
Beginning 9:20 pm
Middle 8:20 pm
End 7:20 pm
Magnitudes
EAST
WEST
NORTH
SOUTH
ARIES
Hamal
Almaak
PERSEUS
CAMELOPARDALIS
ANDROMEDA
Mirach
PEGASUS
Algenib
Markab
Alpheratz
Scheat
CASSIOPEIA
Ruchbah
Caph
CEPHEUS
LACERTA
Polaris
URSA MINOR
Kocab
Dubhe
URSA MAJOR
Thuban
DRACO
Etamin
Alderamin
Deneb
CYGNUS
Vega
LYRA
HERCULES
Albireo
DELPHINUS
AQUILA
Altair
Enif
AQUARIUS
SCULPTOR
Diphda
Fomalhaut
PISCIS AUSTRINUS
GRUS
Alnair
INDUS
PAVO
MICROSCOPIUM
CAPRICORNUS
SAGITTARIUS
Nunki
SCUTUM
CORONA AUSTRALIS
ARA
Shaula
SCORPIUS
Antares
NORMA
OPHIUCHUS
Rasalhague
SERPENS
CORONA BOR.
Izar
BOOTES
Alkaid
CANES VENATICI
Arcturus
VIRGO


STARS FOR OCTOBER
Latitude 25°N
EVENING SKY LOCAL TIME
Beginning 9:20pm
Middle 8:20pm
End 2:20pm
EAST
WEST
SOUTH
Magnitudes
AURIGA
Capella
CAMELOPARDALIS
URSA MINOR
Polaris
Kocab
Thuban
DRACO
CEPHEUS
Alderamin
Etamin
CASSIOPEIA
Ruchbah
Caph
PERSEUS
Mirphak
Algol
Almaak
ANDROMEDA
Mirach
Alpheratz
LACERTA
Deneb
Sadr
CYGNUS
Albireo
LYRA
Vega
CORONA BOREALIS
BOOTES
HERCULES
Rasalgethi
Rasalhague
OPHIUCHUS
Sabik
SERPENS
Altair
AQUILA
SCUTUM
DELPHINUS
Enif
Markab
PEGASUS
Algenib
PISCES
ARIES
Hamal
Pleiades
TAURUS
ECLIPTIC
EQUATOR
Menkar
Mira
CETUS
Diphda
ERIDANUS
AQUARIUS
CAPRICORNUS
Nunki
SAGITTARIUS
MICROSCOPIUM
CORONA AUSTRALIS
PISCIS AUSTRINUS
Fomalhaut
SCULPTOR
PHOENIX
Ankaa
GRUS
Alnair
INDUS
TUCANA


STARS FOR NOVEMBER
Evening sky
Local time
Beginning 5:20 pm
Middle 6:20 pm
End 7:20 pm
NORTH
EAST
SOUTH
WEST
Magnitudes
0 or Less
0 to 3
3 to 6
GEMINI
AURIGA
Capella
CAMELOPARDALIS
Polaris
URSA MINOR
Kocab
Thuban
DRACO
Eltanin
CEPHEUS
Delta Cephei
CASSIOPEIA
PERSEUS
Algol
Almaak
Mirach
ANDROMEDA
PEGASUS
Enif
PISCES
ARIES
Pleiades
TAURUS
Aldebaran
Betelgeuse
ORION
Rigel
EQUATOR
ERIDANUS
Menkar
Mira
CETUS
Diphda
FORNAX
PHOENIX
Achernar
Ankaa
SCULPTOR
AQUARIUS
PISCIS AUSTRINUS
GRUS
Alanair
INDUS
MICROSCOPIUM
CAPRICORNUS
ECLIPTIC
AQUILA
Altair
SERPENS
CYGNUS
Deneb
LYRA
Vega
HERCULES


STARS FOR DECEMBER
Latitude 25°N
EVENING SKY LOCAL TIME
Beginning 9:20pm
Middle 8:20pm
End 7:20pm
Magnitudes
0 or Less
3 to 6
EAST
WEST
NORTH
LYNX
URSA MINOR
Polaris
Kocab
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
Delta Cephei
DRACO
Eltanin
Deneb
CYGNUS
AQUILA
PEGASUS
Enif
Markab
Algenib
Alpheratz
ANDROMEDA
Mirach
PISCES
ARIES
Hamal
PERSEUS
Algol
Capella
AURIGA
Pleiades
Aldebaran
TAURUS
GEMINI
Castor
Pollux
Procyon
ORION
Betelgeuse
Rigel
Saiph
Sirius
CANIS MAJOR
LEPUS
COLUMBA
ERIDANUS
FORNAX
CETUS
Mira
Diphda
SCULPTOR
PHOENIX
Ankaa
Achernar
AQUARIUS
PISCIS AUSTRINUS
ECLIPTIC
EQUATOR

TARAMANDAL PROGRAMME Grade Level: VIII - X

Find out the Planet

Concepts to be developed

1. The planets move in the background of stars.
2. The planets keep a path which lie on a certain part of the sky.
3. The planets can easily be located by consulting the almanac.

Objectives

1. To make the students understand the difference between planets and stars.
2. To help the students identify a planet from their position given in the almanac.
3. To acquaint the students with the path of the planets.

Requirements

1. Planet projectors
2. Star chart (Zodiac)

Procedure

Preparation before the demonstration:

(The presenter should make the following arrangements complete before the students are let in into the Planetarium dome.)

1. Find the position of the planet which you are going to show from the almanac or from any other chart. Project the starfield so that the constellation the planet is in, may remain at a high altitude.

   Take out the Sun stopper near that constellation or any one from either side of it. Fix the planet projector on any of the holes and adjust the mirror in such a way that the planet is projected on the appropriate constellation. With this arrangement complete, cover the mirror with a tape so that the tape can be taken out easily. The tape blocks the light from the planet projector and the planet does not shine on the dome.

   The students can be made to enter when the arrangement is ready.

2. Project the starfield and let the students find out the four directions NSEW. Let the students concentrate on the constellation in which the planet you want to show and then turn the projection lamp off and carefully remove the sticking plaster from the planet projector. Now turn on the projection lamp and let the students observe the constellation carefully and ask them if they find some thing different. Some students may locate the new object.

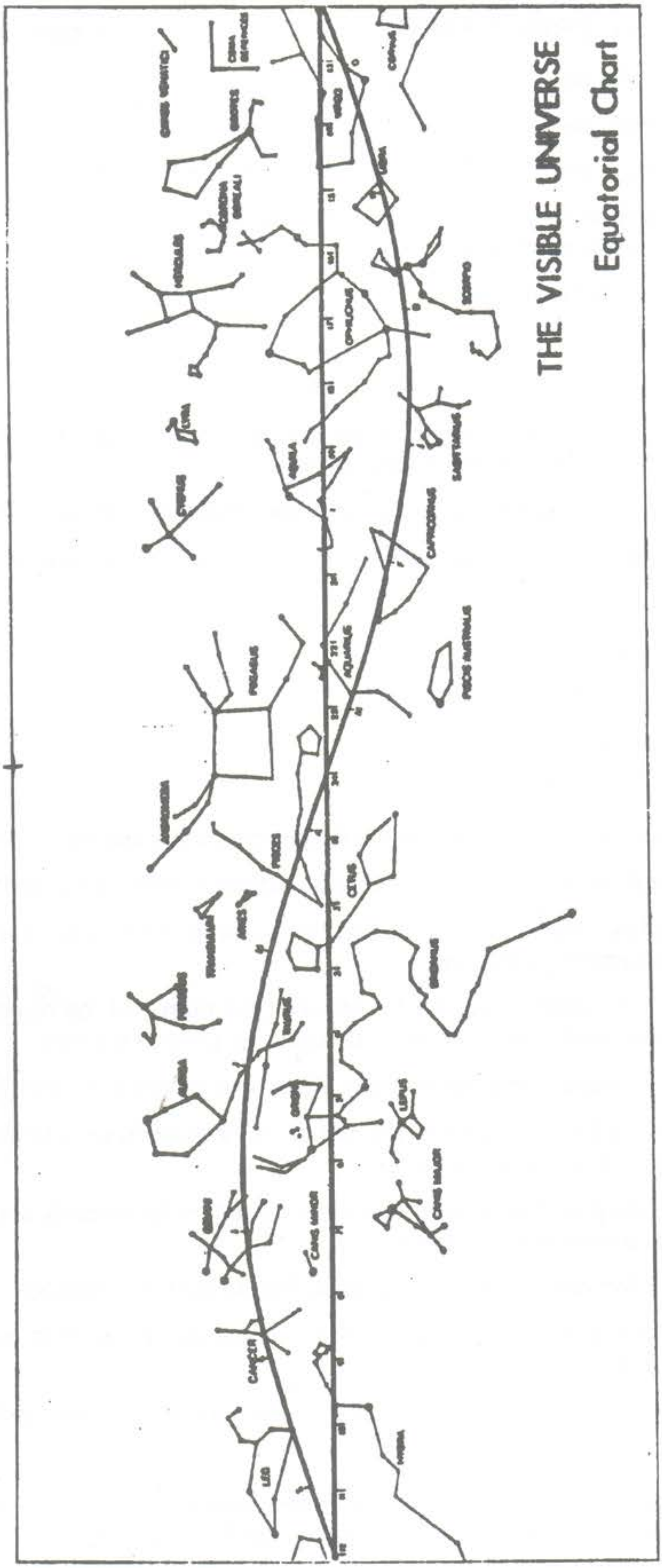
3. At this point distribute the worksheet. Let the students locate the relevant constellation. Let them mark the position of the new object, as seen on the dome, on the map as exactly as possible. Now make the room dark and by turning the mirror shift the planet a little towards the EAST. Turn on the projection lamp and ask the students if they can see the object at the same place. Tell them that the sky they see now is the sky of a few days later. Let them mark the new position of the object. This way shifts the planet to different positions on the map. Ask them to note what happens to the position of other stars. Have their position changed?

Tell them that the observation is carried out for about a month. The students will discover that while the positions of the stars at the background remain fixed with respect each other, the new object moves towards the EAST slowly.

Ask them what the new object is called and tell them how the ancients found them out and named them planets (wanderers) and the stars are known as fixed stars.

Note: The motions of the planets are more complicated. Sometimes they are observed to be moving from EAST to WEST with respect to the fixed stars apart from their a daily EAST West motion and then again continue Eastward movement. This is retrograde motion and is explained in another programme.

CONSTELLATION OF THE ZODIAC OVERLAY


THE VISIBLE UNIVERSE
Equatorial Chart
HERCULES
CYGNUS
LYRA
PEGASUS
ANDROMEDA
PISCES
CETUS
ERIDANUS
AQUARIUS
CAPRICORNUS
SAGITTARIUS
SCORPIO
OPHIUCHUS
AQUILA
PISCIS AUSTRALIS
LEPUS
CANIS MAJOR
CANIS MINOR
CANCER
LEO
HYDRA
VIRGO
LIBRA
BOOTES

TARAMANDAL PROGRAMME

Grade Level: VIII - IX

Retrogression of Planets

Concept to be developed

1. The planets move from West to East with respect to the fixed stars.
2. Sometimes they move in the opposite direction for a short period and again resume their normal direction of movement.
3. All planets have different speeds.

Objective

1. To make the students plot the positions of the planets against fixed stars.
2. To make the students understand that the planets move generally in one direction round the sun but sometimes their motion is retrograde.
3. To make them understand that different planets move with different velocities along their orbits.
4. Finding out the cause of retrogression by an activity outside the Planetarium.

Materials

1. Standard Planetarium set up
2. Planet projector - Mars
3. Map of a small portion of the sky

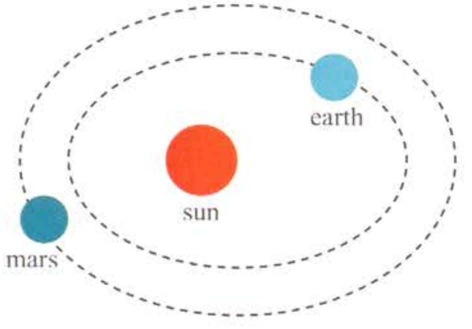
Procedure

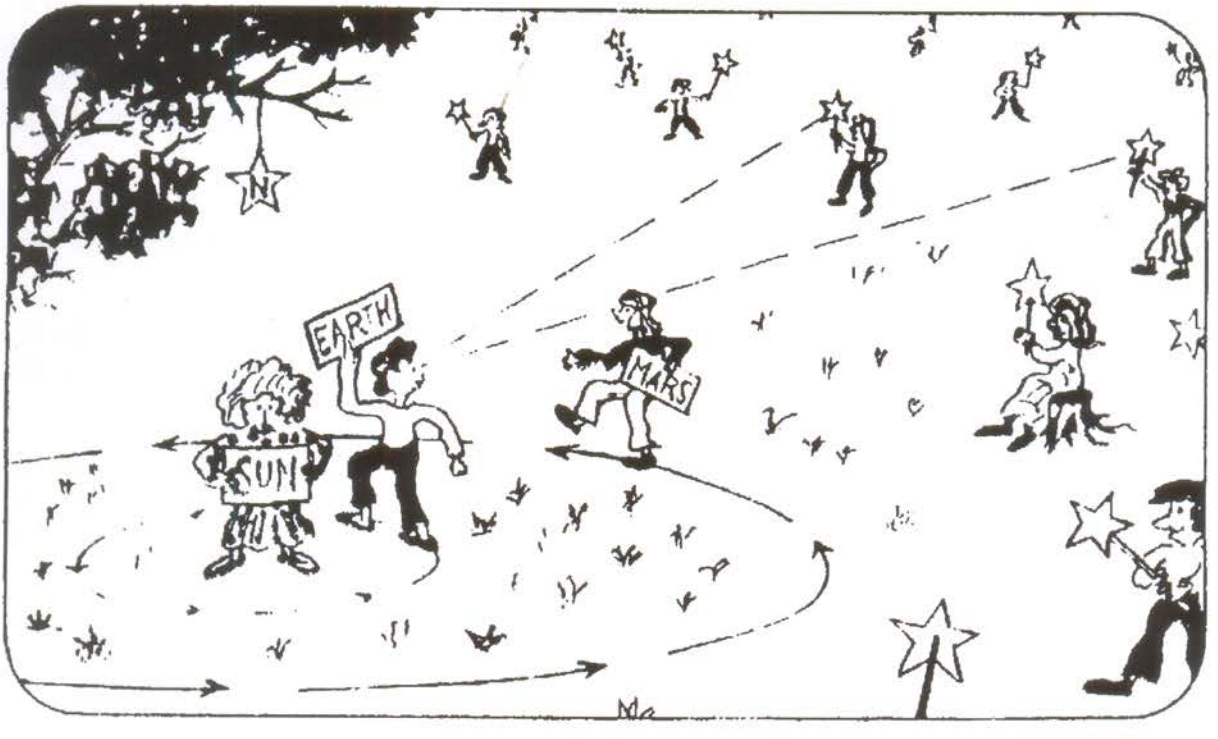
1. Project the appropriate Star Field where the planet is at the time of the presentation.
2. Let the students be acquainted with the constellations (without the planet)
3. Project the planet Mars at its appropriate place and let the students note its position on the sky map as accurately as they can.
4. Turn off the projection lamp and by adjusting the mirror of the planet projector shift the planet to a new position in the forward direction i.e. towards the east.
5. Turn on the projection lamp and let the students note the position of the planet now.
6. Repeat the procedure with the forward motion of the planet several times and let the students mark the positions on the star map.
7. Now reverse the direction of the planet's motion and let the students note the position on the map for several successive positions.
8. Again put the forward motion and ask the student to mark the positions.
9. Let the students join all the positions by a continuous line and find out the motion of the planet in the sky.
10. Through an activity outside the Planetarium explain the cause of this forward and backward movement.

Activity

1. Draw two concentric circles. The radius of the larger one 1.5 times the radius of the smaller one. The larger one is the orbit of Mars and the smaller one is the orbit of the Earth.

2. Divide the two orbits by marks. The spacing of the marks should be larger in case of the Earth than the spacing for Mars (see figure). Place one students at the centre of the circle to represent Sun.
3. Place one student on the Earth orbit and another on the orbit of Mars on the same side of the Sun. Mars will be a little ahead of the Earth in the anticlockwise direction.
4. Place some students in a still larger circle to represent the stars.
5. The `Earth' student moves through one mark and the `Mars' students moves through one mark in the same direction along their respective orbits.
6. Ask the `Earth' who is in the back ground of `Mars' as it moves. For `Earth' Mars is moving backwards with respect to the back ground `Stars'.
7. Other students will see that both Earth and Mars are going in the same direction.
8. When `Earth' and `Mars' come on the opposite sides of the Sun `Mars' is again seen moving in the forward direction with respect to the `Stars' from the Earth.
9. Thus the backward movement of `Mars' is only apparent caused by the relative velocities of Earth and Mars.





TARAMANDAL PROGRAMME

Grade Level VI - X

The Planet, Venus

Concepts to be developed

1. Because Venus is an inferior planet it will appear to move back and forth near the sun.
2. Because of its nearness to the sun Venus is seen either as the "morning star" or "evening star".

Objective

The student should be able to demonstrate an understanding of why Venus appears as the "morning star" sometimes and as the "evening star" at other times.

Materials

STARLAB Portable Planetarium, Projector, Venus planet projector, Ecliptic slide projector mount, 35 mm slide projector, Planet slides, Variable Light Source

Procedure

1. Set the variable Light Source on the east side of the planetarium at the point where the ecliptic meets the horizon. Tell the students that the light will act as the sun. When you have the light off it will represent the sun just below the horizon: when the light is on it will be just above the horizon. Ask the students how far Venus will appear from the sun. (They should have the concept that Venus is quite close to the sun). Explain that Venus is never more than 48^{0} from the sun. To help the students understand the relationship between degrees and what they see, explain that the apparent diameter of the sun is about ½ degree and that from horizon is about 180 degrees.
2. Project Venus using the Venus plant projector or show a slide of Venus just a little above the horizon in the east with the "Sun" (variable Light Source) in the off position. Remind the students that the sun is just below the horizon and therefore can't be seen yet. Ask the students if the projected planet is west of the sun (between the observer and the sun) or east of the sun (on the far side of the sun). The students should determine that the image of Venus is west of the sun. If the students have difficulty with this idea, move the projected image to the east of the sun position. The students should see that the image is on the floor (below the horizon) and couldn't be seen.
3. With the planet image just above the eastern horizon, begin to turn up the side lamps or light source simulating sunrise. Ask why Venus can't be seen during the day. Also ask why Venus can't be seen when its orbit causes it to appear very close to the sun.
4. Now move the Variable Light Source to the west side of the planetarium where the ecliptic intersects the horizon. Explain that when the light source is off it represents the sun just after sunset. When the light source is on it represents the sun just before sunset.
5. With the light source off, position the projected image of Venus just above the western horizon. Ask the students if Venus is now east of the sun (between them and the sun) or west of the sun (on the other side of the sun). They should determine that Venus is now east of the sun or between them and the sun. Now turn on the side lamps or variable light source and ask why Venus can't be seen before sunset. Also ask why Venus can be seen only a short time after sunset.

TARAMANDAL PROGRAMME

Grade Level VI - X

Apparent Stellar Motion

Concepts to be developed

1. A given constellation to return to its original position in the sky from one night to another, it would take 23 hours and 56 minutes or 1,436 minutes.
2. Since the star "circle around" the earth once during that time, it covered 360 ^{0}. Any star appears to move 1/1435 of 360 ^{0} in one minute. This is 360/1,436 or .25 $^{0.}$
3. Any star or constellation along the ecliptic moves westward about the diameter of the full moon every 2 minutes through the night and day.

Objectives

The student should be able to give a numerical estimate for the amount of apparent stellar motion per 2 minutes.

Requirements

1. Projector
2. Starfield Cylinder
3. Variable Light Source (optional)

Procedure

1. An easy way to grasp the nightly "movement" of the stars is to time-lapse the night. Assume that you are looking at the night sky when it's spring or fall, there would be 60 x 60 x 12 or 43,000 seconds of night on a given evening. By making things happen 10,000 times faster, the night would only last 43 seconds. During this 43 second night, a star just rising as "night" starts should set at dawn 43 seconds later. The Starfield Cylinder on the projector will accommodate this movement easily. With practice using the daily motion switch, we can move the cylinder uniformly so that the reference star rises at sunset and 10 seconds later is exactly southeast. Twenty seconds after sunset, the star should be at its maximum height in the sky due south. At 30seconds, the star should be exactly southwest, and at 40 seconds; it should be setting just as dawn breaks.
2. The variable light source may be used to simulate the setting and rising sun, otherwise, a capable student can control the sun at proper direction.

Note: Remember, every 10 seconds of daily motion in STARLAB equals 1 hour of apparent sky motion.

TARAMANDAL PROGRAMME Grade Level VIII-X

How distant are the Planets

Concepts to be developed

1. Motion of the planets depends on their distance.
2. By observing the movement of any planet its period of revolution can be found out.
3. As an advanced exercise, the relation between period of revolution and the distance can be found out.
4. To develop the concept of the size of the planets.

Objective

1. To give students an idea of judging the distance of the planets.
2. To give the students an idea of the orbital speed of the planets.
3. To give the students an idea about calculating the revolution period of the planets from the motions over a certain period of time.
4. To give the students an idea about the size of the planets.

Requirements

1. Planet projectors (Mars, Saturn, Jupiter)
2. Star map

Procedure

1. Remove three sun stoppers from the cylinder preferably near the middle sky and fix three planet projectors, Mars (red), Saturn (yellow), Jupiter (white). These three planets are chosen as the colours are different. The three planets are projected on a constellation. Let the students mark the position of the planets on the star map. Turn off the projection lamp and shift Saturn very little, Jupiter a little more, Mars still more towards the EAST.
2. Turn on the projection lamp and now let the students mark the positions of the planets on the star chart. Again turn off the projection lamp and shift the planets as was done in the previous case. Turn on the projection lamp and again let the students mark the new positions.
3. Ask the students what do they observe regarding the displacement of the planets. What is the cause of this differential displacement? The students may hit upon the explanation that the slower the movement, the more distance is the planet. Let them identify the planets from their motions. Now tell them that Mars moves round the Sun in 686 days (about 2 years) Jupiter in 12 years and Saturn in 30 years approximately.

   Ask them whether they can estimate the size of the planets. Which is bigger though they look nearly the same size.

   Ask them if they can draw any relation between the distance and the period of revolution of the planets.

TARAMANDAL PROGRAMME Grade Level VIII - X

Sun's path - the year

Concepts to be developed

1. The Sun moves with respect to the fixed stars along a definite path.
2. The constellations lying in the path of the sun were identified by the ancient people as the signs of the Zodiac.
3. After one year the sun comes back to the same sign.

Objectives

1. To let the students understand that the Sun, in addition to its daily East-West motion, moves against the background stars.
2. To help the students find out and plot the Sun's path.
3. To give the students the idea that the year is the time for the Sun to come back to the same sign it was seen in at the beginning of the programme and the cycle is repeated.

Requirements

1. Starfield cylinder
2. Sky maps for the current month and one six months from the current month, Zodiac map.

Procedure

1. Set the planetarium for the home latitude for the current month at Sunset time.
2. Remove the Sun stopper for the month. Turn on the daily motion switch and bring the Sun to near setting position. Ask the students to carefully observe the position of the Sun on the dome and remember it.
3. Now replace the stopper and ask the students to observe the constellation at the Sun's background and identify it on the map. Ask them to mark the Sun on the constellation and write the name of the month.
4. Open the Sun stopper of the next month and repeat the previous procedure. Let the students observe the background constellation, identify it on the map and mark the Sun's position with name of the month.
5. This way run through all the Zodiacal signs and let the students mark the positions (use two star maps).

   When the Sun again comes to the starting point let the students join the Sun's position by a line and ask them if they had seen the Sun against any other constellation except the ones they had noted. The Sun has come to the constellation it started from and it will repeat its journey along the line drawn by the students. This is the fixed path of the Sun - Ecliptic.

   Tell the students that the concept of the year came from a complete journey of the Sun among the constellations and its return to the starting point.

   As an additional information it can be told that actually the Earth is moving round the Sun and thus the background of the Sun changes. Starting from any point when the Earth completes one revolution the Sun is again seen against the same constellation.

TARAMANDAL PROGRAMME

Grade Level VIII - X

How long a constellation is visible?

Concepts to be developed

1. The length of time a constellation stays above the horizon depends on the observer's position on the Earth's surface.
2. The higher the latitude the longer a Northern constellation stays in the sky.
3. At the Equator all constellations stay for 12 hours in the sky.

Objectives

1. To let the students find out the fact that though the Earth moves about its axis in 24 hours, all constellations are not visible in the night sky for same length of time.
2. To find out the period constellations in the North and South take between rising and setting.
3. To find out the period of visibility of the constellations at different latitudes.

Requirements

1. Starfield projection cylinder
2. Stop watch / Digital watch / Centre second watch

Procedure

1. Set the TARAMANDAL for home latitude. Open one Sun stopper and put on the daily motion. Let the students count the time from one Sunrise to the next Sunrise. Ask them how many hours are there between two consecutive Sunrises. The answer is 24 hours. Let them note down the number of minutes and seconds it takes the sun to go round once in the TARAMANDAL. Let them assume this time equivalent to be 24 hours.
2. Switch off the light and bring the sun at sunset position. Let the students observe the constellations near the Eastern horizon both towards the North and towards the South. Let some students observe the Northern and others observe the Southern constellations. Students sitting along the Eastern wall of the TARAMANDAL may observe the constellations over head (near the North). Now tell them that like the Sun all stars rise and set. Tell them to keep close watch to the assigned constellations or stars and observe which constellations set first.
3. Turn the daily motion on and tell the students to start counting. One group after another will report setting time and let them note the time it takes. Let them convert the TARAMANDAL time to real time by simple proportion.
4. Now increase the latitude to 45 degrees and let them repeat the observations and record their findings. Now ask them what will happen if they go farther North and to the North Pole. Let them come up with many answers. Show them the sky at the North Pole where they will find some stars are never visible and other remains above the horizon for 24 hours.

CONSTELLATION VISIBILITY TIME DATA SHEET

Latitude	Position of the Star or Constellations	Time span of visibility in Taramandal	Real Time	Remarks

TARAMANDAL PROGRAMME

Grade Level VIII-X

Latitude and Apparent Star Movement

Concepts to be developed

1. The apparent East-West motion of the stars is a result of the rotation of the Earth. This motion with respect to the horizon varies with the latitude of the observer.
2. At the Poles, all stars appear to move along paths parallel to the horizon.
3. At the Equator all stars appear to rise and set at right angles to the horizon.
4. In other latitudes some stars appear to be non-setting while others appear to rise and set at various angles to the horizon.

Objectives

1. Given a pattern of diurnal star motion the students will be able to determine the approximate latitude of the place.
2. The students will be able to describe the effect of latitude in the apparent pattern of star movement.

Materials

1. Note pads
2. Pencils
3. Flash lights
4. Starfield Cylinder

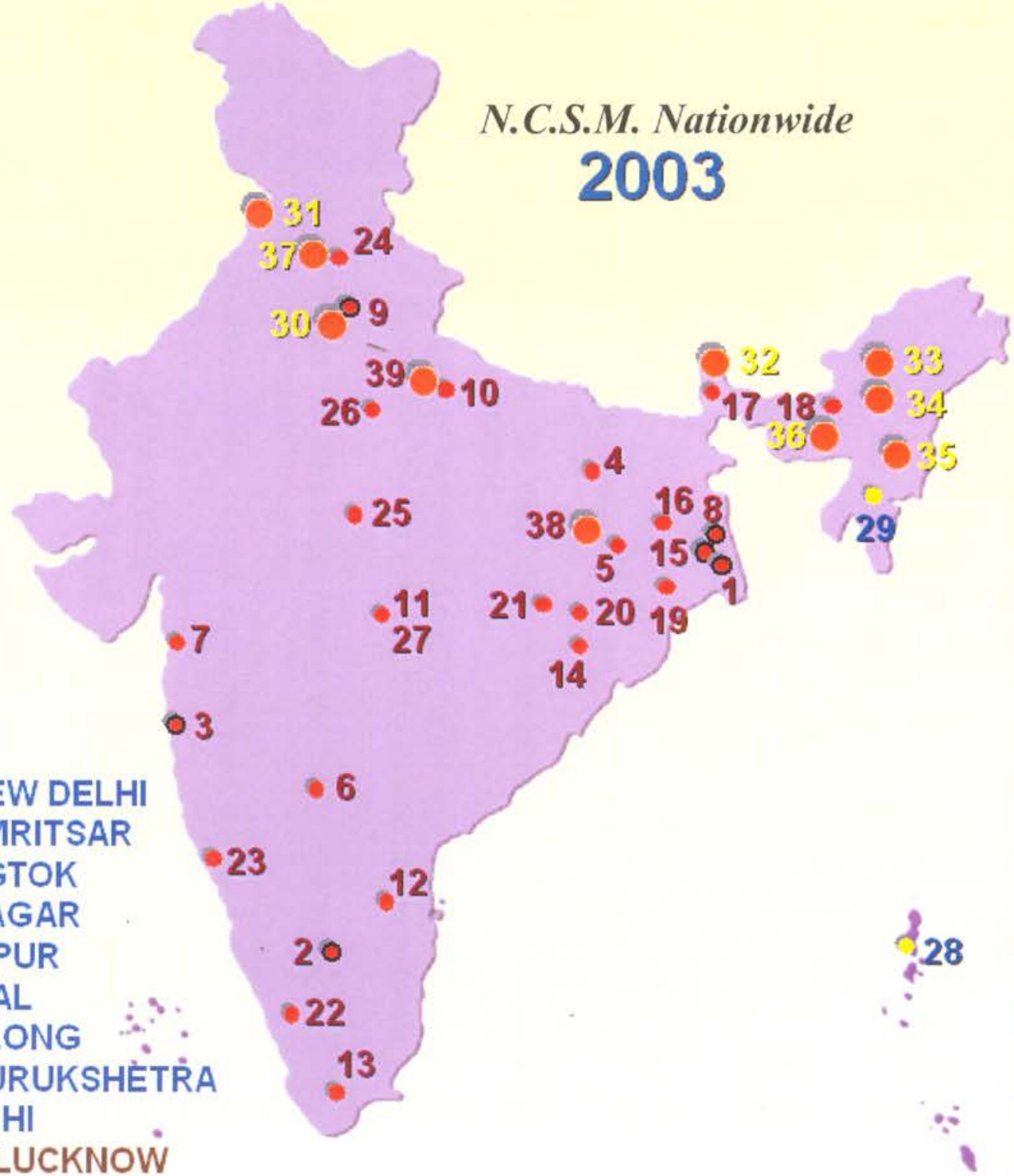
Procedure

1. Set the planetarium for home latitude, (the night of visit with stars visible). Point out the cardinal points.
2. Ask the students to locate the Polaris. Let them measure the latitude of the Pole Star approximately and this will be the home latitude.
3. Start daily motion and ask the students to observe and sketch on the note pads. The daily motion is to be repeated to ensure that all the students have noticed the movements circumpolar and other stars.
4. Change the setting to the North Pole. Let the students identify the Polaris. The Polaris will be directly above the projector its latitude is 90 degrees.
5. Tell the students to observe the daily motions of stars. Stress the point that the path of the stars are parallel to the horizon.
6. Change the setting to the Equator and let the students observe the Pole Star at the horizon. Repeat the daily motion till the students observe that all stars rise and set at right angles to the horizon.
7. Change the setting to any latitude between 0 and 90 repeating the procedures used before. At these positions the paths of the stars are inclined to the horizon.

Notes / References

N.C.S.M. Nationwide

2003



1. BITM, KOLKATA
2. VITM, BANGALORE
3. NSC, MUMBAI
4. SSC, PATNA
5. DSC, PURULIA
6. DSC, GULBARGA
7. DSC, DHARAMPUR
8. NCSM HQRS. & CRTL, KOLKATA
9. NSC, DELHI
10. RSC, LUCKNOW
11. RSC, NAGPUR
12. RSC, TIRUPATI
13. DSC, TIRUNELVELI
14. RSC, BHUBANESWAR
15. SCIENCE CITY, KOLKATA
16. DSC, BARDHAMAN
17. NBSC, SILIGURI
18. RSC, GUWAHATI
19. SRSC, DIGHA
20. SC. PARK, KAPILAS
21. SRSC, DHENKANAL
22. RSC & PLANETARIUM, CALICUT
23. SRSC, GOA
24. KPSC, KURUKSHETRA
25. RSC, BHOPAL
26. SAC, GWALIOR
27. RAMAN PLANETARIUM, NAGPUR
28. SC, ANDAMAN
29. SC, AIZAWL
30. NASM, NEW DELHI
31. MRSP, AMRITSAR
32. SC, GANGTOK
33. SC, ITANAGAR
34. SC, DIMAPUR
35. SC, IMPHAL
36. SC, SHILLONG
37. KCMP, KURUKSHETRA
38. SC, RANCHI
39. RS CITY, LUCKNOW

NATIONAL COUNCIL OF SCIENCE MUSEUMS • INDIA •