Teachers Guide For: **Third Grade Program: Cycles: The Diurnal Cycle, Seasons, and the Moon**

Includes the full dome show: **Tilt (30 min)**

OBJECTIVES:

- Review of the diurnal cycle: day and night and rotation
- Introduce the annual cycle: Earth's revolution that, along with axial tilt results in changing seasons.
- To gain an understanding of why the night sky changes with the seasons.
- To understand the lunar cycle and why moon phases occur

This program primarily targets **VA. Science standard: Earth Patterns, Cycles and Change 3.8a: Patterns of natural events such as day and night, seasonal changes, simple phases of the moon, and tides.**

Program Description:

Most curriculum programs in the Planetarium follow a similar format: a live taught introduction to the material to be covered, followed by a full dome immersive video presentation tied to that material, and a post-show live demonstration on the simulated sky to reinforce those concepts and expand upon the material covered.

Live Introductory Lead-In to Full Dome Show:

In the darkening theater the students are asked to define a cycle in nature – not by giving examples but describing what basic properties all natural cycles have in common. (a series of events or steps that occur in some order and always repeat that order continuously.) From there examples are solicited from the audience, before steering the responses to cycles most likely taught in a planetarium setting. (day/night, the seasons, moon phases.) Using a globe and

flashlight, day and night are reviewed and the cycle of the seasons are introduced and demonstrated with the globe. The group is now prepared for the full dome show **Tilt.**

TILT (30 min)

Annie, an older elementary student is completing a project for school to demonstrate the mechanics of the seasons, when she runs into difficulties making the project work. Presently, her meddlesome younger brother shows up playing with his toy robot and feigns interest in resolving her project problem by forcing his toy robot onto the project to "fix" it which breaks a key part. Quick to make amends, he brings out a toy rocket to help the skeptical Annie understand the seasons when things suddenly change and they find themselves inside the rocket in space with toy robot Kelvin, now life size, and in command, embarks on detailed lesson to the children of how the seasons come about. After fully fleshing out the mechanics of the seasons they return to reality, the riddle of the seasons solved, repair the faulty project and the show concludes not before some peril and suspense are brought into the story.

Post Full Dome Show Live Segment

As movie credits roll, a transition is made to the simulated daytime sky, where the students review certain concepts conveyed in the show. The Sun's changing path across the sky and midday altitude are demonstrated for the current season, and then the other seasons, all due to the axial tilt of the Earth. Characteristic warmer and cooler temperatures associated with the different seasons are not simply due to the length of day and night, but also the intensity of light caused by the insolation angle resulting from axial tilt. This is demonstrated in the front of the theater using a white board and flashlight to show how the intensity of sunlight in winter is also much less due to the lower angle and warmer in the summer due to the higher angle of insolation. After transitioning to night time, the Moon is located and phases are demonstrated. The phases are shown to be the result of observing different portions of the Moon's illuminated side (day side) and darkened side (night side) as it revolves around the Earth relative to the Sun illuminating it.

Finally, the cycle of seasonal constellations is demonstrated and the changes visualized by imagining the gaze from "ones bedroom window" slowly sweeping across the celestial vault as the Earth revolves around the sun.

Before Your Planetarium Visit:

Vocabulary words to be familiar with:

Cycles, rotation, revolution, tilt, axis, orbit, seasons, moon phases, gravity, tides

After Your Planetarium Visit:

Tasty Seasonal Sunlight Intensity Demonstration

The tilt of the Earth changes the length of time the Sun is in the sky with the changing seasons. Not only that but the intensity of the sunlight also changes. During the show, using a flashlight and white board with a circle drawn in the middle, a beam of light is shined directly down onto and completely inside the circle depicting sunlight in the summer. Then, the flashlight is tipped so the light completely fills the circle but spills out well beyond the limits of the circle as well. It becomes apparent, the light within the circle is less intense (winter) because the same beam of light once contained inside the circle is now spread over a much larger area. A fun way to "try this at home" is to take two identical pieces of bread and two separate teaspoons of peanut butter (if allergic any other spread will do). On one slice of bread place the whole teaspoon peanut butter on one corner of the bread. One the other slice, completely cover the bread with other teaspoon of peanut butter. Now the fun part: bite off the corner of the slice with the whole teaspoon of PB, then bite the same corner off the other piece of bread where the teaspoon of PB is spread over the entire slice. Which slice demonstrates the analogous intensity of summer sunlight, and which one winter?

Observing the Moon's motion relative to the starry background, as it revolves around the Earth.

As the Earth rotates, while facing south we see the Sun, stars and planets appear to move from East to West across the sky. The Moon, due to Earth rotation does the same thing. However, it also moves from west to east in its orbit revolving around the Earth. This motion can be observed by trying the following activity.

The student will need pencil and paper, a flashlight to draw in the dark and a wrist watch to note the exact time of observation.

The student should start the activity when the Moon is at or near first quarter so it will be visible in the west in a fully darkened sky before it sets. Have the student note the time they make the first observation. Locate at least two or bright stars seen near the Moon. These stars become the reference stars which will remain stationary relative to the Moon on subsequent nights' observations. The student should draw a picture of the Moon and the bright reference stars and note the time and date on a piece of paper. Observe the Moon and stars an hour later and verify that all objects appear to have moved farther west (due to Earth rotation). Afterwards go inside and prepare three more evenings' observation charts by tracing the exact

position of the reference stars onto three more sheets of paper. Do NOT trace the Moon's position onto the paper. That will be done over the next three nights.

On the next three nights, go out at the same time and observe the Moon's location. Sketch it's position onto the reference star chart relative to the location of the reference stars. Put the time and date of observation on the sheet. Observe the sky one hour later to confirm that the Moon and stars have all moved further west together.

After the three successive nights of observation, review the charts in order by date. Does the Moon stay in the same place relative to the stars? The activity demonstrates that the Moon, while appearing to move east to west among the stars in the sky daily, as the Earth rotates, ALSO moves west to east relative to the surrounding stars as it follows its orbit revolving around the Earth.

Useful Resources:

APS Science Unit Planner: SOL 3.8a The student will understand and investigate patterns and cycles in nature: day and night, seasonal changes, simple moon phases and tides: https://www.apsva.us/wp-content/uploads/legacy_assets/www/bf2b959078-3.8__Earth_Patterns.pdf

Stellarium is a free planetarium app for Mac and Windows computers available from http://stellarium.org/ Stellarium replicates the sky from any point on Earth and models daily and annual motion of the Earth and the motion of the Moon. It is an excellent learning tool for students that allows them to observe the sky in different seasons; displaying seasonal constellations, seasonally changing day length, and the lunar cycle. It allows the user to move to different geographic locations on earth to witness seasonal differences like "midnight sun" and twenty four hour darkness at the poles. The Mac and Windows version are free to download and are updated regularly.