Solstice and Equinox Curriculum

45 to 60 minutes for 6th-8th grades

Notice

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Objectives

Students will learn:

- The dates of the solstices and equinoxes;
- The origin and definitions of the words 'solstice' and 'equinox;'
- What occurs on the solstices and equinoxes; and
- How solstices and equinoxes relate to the seasons on Earth.

Required Materials

- Earth on a stick (globe with handles at north and south poles to represent axis)
- 4 labels on strings: vernal equinox, summer solstice, autumnal equinox, winter solstice
- Sticky notes (5 different colors, if possible)
- Writing instrument
- Light and laser pointers

I. Introduction *(5 minutes)*

A) Inform students that you'll be talking about the solstices and equinoxes today. Ask students what those words mean ***[**the words are from Latin: solstice means 'sun stands still;' equinox means 'equal night'**]*** and when the solstices and equinoxes happen. ***[**Vernal equinox occurs on or around March 21; summer solstice on or around June 21; autumnal equinox on or around September 23; winter solstice on or around December 22.**]*** Tell students that you'll be using the planetarium to explore what the solstices and equinoxes are, why they occur, and how they relate to the seasons on Earth.

B) Inform students of method of entry, rules, and expectations for behavior inside the planetarium, then enter.

II. Exploring Tonight's/Today's Sky *(10 to 15 minutes)*

A) ***[**When all are in and seated, darken the planetarium to allow students to better see the night sky.**]*** Inform students that before you get to the solstices and equinoxes, you'll first be exploring tonight's sky. ***[**If you're exploring this topic within two weeks of a solstice or equinox, choose a different date for this part—Groundhog Day or Halloween would work well. This first section is written as if you will be using the current date.**]***

First you'll need to figure out where the directions are in the planetarium. In the northern hemisphere, ask students how you can do that, leading them to the idea of first finding Polaris to determine north. Ask them how you will recognize Polaris among all the visible stars. Share the tip of finding the Big Dipper first, and let a student point it out with a LIGHT pointer. Inform students that they can use the 'pointer stars' to find Polaris. After finding Polaris, go over the other three directions and bring up the cardinal points to help students remember where the directions are.

B) Now that you know which direction is which, you can begin thinking about the solstices and equinoxes. Solstices and equinoxes are special because of where the sun rises and sets on those days. Why would that matter? ***[**Where the sun rises and sets controls how much daylight we get, which in turn controls which season we experience.**]*** Ask if any of the students noticed where the sun rose this morning. If they didn't notice or weren't up for the sunrise, ask for two or three predictions of where it rose.

Write each prediction on a sticky note, being sure to label each with the student's name and the appropriate date, and have the students place the sticky notes on the dome where they predict the sun will rise. Go back in time to just before sunrise, turn off the atmosphere, and advance in time until the Sun becomes visible on the eastern horizon. How were their predictions? Were they close? Way off? Why? ***[**Take down all but one of the sticky notes with predictions, and move it to the actual spot, if necessary.**]***

C) In what part of the sky--north, south, etc.--will the sun reach its highest point? ***[**Due south for the northern hemisphere; due north for the southern.**]*** How high in the sky do students think the sun will get today? All the way up to the zenith? Just above the horizon? Take two or three predictions, write these predictions on sticky notes, being sure to label them with the current date, and have the students place the sticky notes on the dome where they predict the highest point of the sun's path will be. ***[**Note: In portable domes above 16ft/5m in diameter it may be difficult for students to reach high enough to attach their predictions. In that situation, simply have students choose a star on or near the meridian to represent their prediction.**]*** How were their predictions? Were they close to the actual spot? Way off? Why? ***[**Take down all but one of the sticky notes with predictions, and move it to the actual spot, if possible.**]***

D) Where do the students think the sun will set tonight? ***[**Take two or three predictions, write these predictions on sticky notes, being sure to label them with the current date, and have the students place the sticky notes on the dome where they predict the sun will set.**]*** How were their predictions? Were they close to the actual spot? Way off? Why? ***[**Take down all but one of the sticky notes with predictions, and move it to the actual spot, if necessary.**]***

III. Exploring the Solstices and Equinoxes *(20 to 30 minutes)*

A) Ask students if they remember when the next solstice or equinox will be. Advance in time to that date, and remind students that the solstices and equinoxes are special because of where the sun rises and sets. As above, take and label predictions about where the sun will rise and set, and how high it will climb in the sky, then test the predictions. ***[**If you have sticky notes in five different colors, use a different color for each date you're exploring.**]*** How have the sun's positions changed from what you found in part II? Why did they change? Ask students to remind you what the word solstice or equinox means, depending on which one you're exploring in this part. How does the definition relate to the sun's positioning?

B) Repeat predictions and testing for the remaining three solstices and equinoxes. Remind students of the definitions as you progress.

C) **OPTIONAL:** Show the variations in the maximum altitude of the sun over one full year. Set the sun at its maximum altitude for whatever date your projector is currently showing ***[**the sun due south for the northern hemisphere and due north for the southern hemisphere**]**.* Jump forward in time week by week until one year has elapsed.

D) **OPTIONAL:** Ask students how they think latitude affects the path of the sun. Change your latitude by at least 20 degrees and repeat predictions for the sun's path. If time allows, go to the other hemisphere and repeat.

E) Inform students that you'll be exploring why we experience solstices and equinoxes outside the dome, and prepare students to exit.

IV. Earth on a Stick *(10 minutes)*

A) When all are outside and seated, ask students if they know the relevance of the dates of the solstices and equinoxes. ***[****Some cultures use these dates to mark the passage from one season to the next. Some use the dates to mark the midpoints of the seasons.**]*** Ask students why we experience different seasons on Earth. Lead students to the idea that seasons result from Earth's axial tilt of about 23.5 degrees toward the north star, which affects how much sunlight an area gets throughout a year. Show the earth on a stick, pointing out that the stick represents Earth's axis, and tilt it about 23.5 degrees toward north.

[*Note: watch out for the common misconception that seasons result from Earth being closer to the sun in summer and farther in winter. While Earth's orbit is elliptical, Earth's distance from the sun does not cause the seasons.**]***

- You will need five volunteers to help you model why this happens.
- One volunteer will be the sun. Hang the sun label around his/her neck, and place that volunteer in the middle of your circle.
- Another volunteer will be the vernal equinox, one the summer solstice, one the autumnal equinox, and the last the winter solstice. These four volunteers should be labeled and placed in the appropriate order around the sun, moving from one season to the next in a counter-clockwise fashion, and equidistant from each other.
- You will be Earth. Remind students that the earth travels around the sun in a counter-clockwise orbit, tilted about 23.5 degrees on its axis--northern hemisphere tilted away from the sun in the winter, toward the sun in summer. Remind students that at all times of the year, Earth's north pole is tilted toward Polaris. You can either tilt the top of your head toward Polaris, or use the earth on a stick and tilt its north axis toward Polaris.
- Travel one full circuit around the sun, without rotating but maintaining the axial tilt. Ask students how long that trip once around the sun takes in real life.
- Ask students how else the earth is moving, leading them to the idea that Earth is rotating on its axis, with one full rotation equaling one day.
- Now you're going to put the two motions together. You can start your voyage wherever you like, but remember to tilt your north pole about 23.5 degrees

toward Polaris and maintain that angle. Take observations from seated students about what part of the earth the sun is shining on when you reach each volunteer.

- Ask students how the angle of the sun affects the amount of daylight in each position. If necessary repeat the trip around the sun until students reach an understanding. Remove the labels from the volunteers and have them return to their seats.
- If you explored the solstices and equinoxes from different latitudes inside the dome, draw students' attention to different latitudes in this model.

[*As an alternative, you may decide NOT to label the four solstice and equinox volunteers until you've had a chance to demonstrate how Earth's axial tilt causes the seasons. For example, you could ask the students in the audience which volunteer they think represents the vernal equinox after they've seen one or two full revolutions around the sun.****]***

V. Conclusion *(5 minutes)*

A) Ask students what they learned today. What do the words solstice and equinox mean? What causes the seasons on Earth? Remind them when the next solstice or equinox will be and encourage them to continue noting where the sun rises and sets.