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
- Digitarium® planetarium system set for daytime on a date at least four weeks from a solstice or equinox; atmospheric effects and landscape turned on

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, speed up time to let the sun set, then turn off the atmospheric effects and landscape.]* 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 four weeks of a solstice or equinox, choose a different date for this part—February 2, May 1, August 1, or October 31 work well. This first section is written as if you will be using the current date.]*

First you'll need to figure out which direction is which in the planetarium. In the northern hemisphere, there's one star that is particularly helpful for finding directions: Polaris, the north star. How can we find Polaris? *[Share the trick of finding the Big Dipper first, and let a student point out the Big Dipper with a LIGHT pointer.]* After the Big Dipper has been pointed out, show how to use the pointer stars to find Polaris, review the other directions, and turn on cardinal points.

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? Ask if any of the students noticed where the sun rose this morning. If they didn't notice or weren't up in time, 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 [use a flashlight to help them see in the dark dome].* Advance in time until the Sun becomes visible on the eastern horizon. How close were their predictions? 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.]* Display and define the meridian. How many degrees above the horizon do students think the sun will reach today? Take two or three predictions, and if desired, write these predictions on sticky notes labeled with the current date. Have students place the sticky notes on the dome to predict the sun's maximum altitude. *[You can also ask students to simply say the number of degrees for the maximum altitude.]* How were their predictions? Put a sticky note labeled with the current date at the correct spot on the meridian.

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? 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 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? Remind students 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 Digitarium® system is currently showing *[the sun due south for the northern hemisphere and due north for the southern hemisphere]*, display the meridian, and jump forward in time week by week until one year has elapsed.

D) **OPTIONAL:** Display the ecliptic and celestial equator, then show how Earth is directly over one of the intersections of these lines on each equinox.

E) **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 opposite 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 slightly 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 put the two motions together. 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.