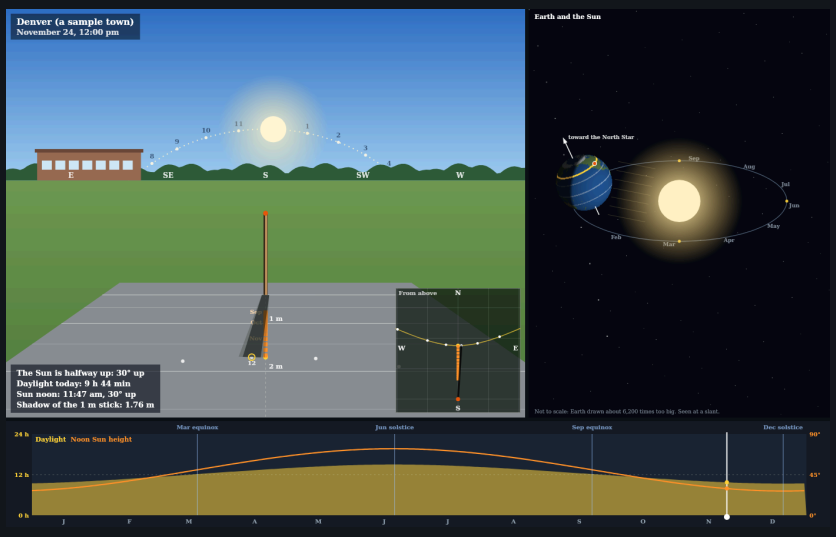
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Sun and Seasons Lab: The Shadow Stick

Grades 6-8 · 45 minutes

Earth and space science · Astronomy



Slides, rubric and answer key **Print and go** **No student accounts**

Chromebook friendly

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code and a shadow log for a real stick
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in grades 4 and 5 and in high school Earth and space science
- Standards: NGSS and Texas TEKS

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A shadow stick is the best real seasons lab, and the hardest to run: the school year has no June, clouds take whole weeks, and noon on the clock is not noon in the sky. Students follow a virtual stick in Denver through an equinox day, mark the noon tip week by week as it marches out toward December, then go outside with a real stick and a tape measure and check their shadow against the app. On a cloudy day, the app keeps their prediction and a sample reading takes the place of the real one.

At a glance

ESSENTIAL QUESTION

What can a stick's shadow tell us about the Sun and the seasons?

OBJECTIVES

Students will be able to:

- describe how a stick's shadow changes length and direction through a day, and find sun noon from the shortest shadow
- predict how the noon shadow changes from week to week through the fall
- measure a real shadow and compare the Sun's height worked out from it with the model's
- explain why a measured shadow and the model rarely match exactly

VOCABULARY

Shadow stick, Sun noon, Sun's height, Prediction, Daylight saving time

STANDARDS

MS-ESS1-1, 112.26(b)(9)(A)

TIME AND MATERIALS

45 minutes, grades 6-8.

- One computer or Chromebook per student
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the work
- For each group of three or four: a straight stick about 1 meter long (a meter stick held upright works), a tape measure, and a watch or phone for the time
- Optional: a level or a string with a weight, to check the stick stands straight

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/sunseasonslab?lesson=the-shadow-stick&ref=tpt-sunseasonslab-3, press `Find my town`, pick your town and press `Sun noon` to see when the shadow will be

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet, scored with the rubric.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they do is stored on our server unless they choose to save. The app never reads where a

shortest today; the outside part works at any time, but within an hour of sun noon the shadow changes slowest. Pick a flat, sunny spot. If it is cloudy, use the cloudy-day plan below. About ten minutes.

device is: a town is picked from a list or a map.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 5	**Warm-up** Hook	Show the title, essential question and Today I can slides (about 1 minute). Then the warm-up: students point where the shadow goes at 9, at noon and at 4.	Answer the warm-up on the worksheet.
5 to 10	**Direct instruction (I do)** Model it	Project the app. Show A day of shadow tips: the white dots are where the shadow's tip was each hour, the yellow ring sun noon. Then The noon tip through the fall. Read the safety rule aloud: look at the shadow, never at the Sun. > **It's working when:** The From above chart in the corner of the yard is the clearest view of the tips: it is the stick seen from straight overhead.	Fill in the vocabulary.
10 to 18	**Guided practice (We do)** A virtual stick together	Students open the link or scan the QR code. The guide asks them to press Play, then Sun noon, mark this week's noon, press A week later five times, and open Measure a real shadow. > **Watch for:** Students who press A week later before marking the first week. Marking starts with Mark this week's noon; after that each week is marked by itself.	Follow the guide and write the noon shadow for each week in the log.
18 to 38	**Independent practice (You do)** A real stick outside	Groups go outside with a stick, a tape measure and the time. Each measures the stick and the shadow, from the foot of the stick to the middle of the fuzzy edge at the tip, and writes down the clock time. Back inside, each student types the reading into Measure a real shadow and presses Check against the app. On a cloudy day, use the cloudy-day plan. > **If they ask:** "Why is the tip of a real shadow fuzzy? Where should you measure to?" The fuzzy edge	Measure, log the reading, and check it in the app.
38 to 45	**Closure** Showcase and exit ticket	Show the Showcase slide. Ask which groups matched (within 2 degrees) and what the others think went wrong. Hand out the exit ticket.	Answer the exit ticket.

Before you teach: a ten-minute walkthrough

Open mytekdev.com/try/sunseasonslab?lesson=the-shadow-stick&ref=tpt-sunseasonslab-3. Denver on September 22, the equinox, at 9 in the morning, with every control showing. The white dots on the pad are where the shadow's tip is on each hour; the yellow ring is sun noon.

1. **A day.** Press `Play` (an hour a second) and watch the tip move along the dots, which on an equinox lie in a straight east-west line.

2. **Sun noon.** Press `Pause`, then `Sun noon`: 12:53 pm, the Sun 50 degrees up, the shadow 0.83 m long and pointing north.
3. **Noon marks.** Press `Mark this week's noon`, then `A week later` five times. Six orange marks, out to 1.31 m on October 27.
4. **A real shadow.** Press `Measure a real shadow`. Type a day, the clock time, the stick and the shadow, and press `Check against the app`. Within 2 degrees of the Sun's height is a match.

> Safety: nobody looks at the Sun, with or without sunglasses. Students look at the shadow and the tape measure. The app says so in the real shadow box.

Background for the teacher

A shadow points away from the Sun, and the lower the Sun the longer it is: the Sun's height is atan(stick / shadow). The shortest shadow of the day comes at sun noon and points due north in most of the United States. In Denver a 1 m stick's noon shadow is 0.29 m in late June, 0.83 m at the equinoxes and 1.97 m in late December.

A real stick is hard to run for a whole year: the school year has no June solstice, clouds can take weeks, and sun noon falls near 1 pm under daylight saving. The app's stick stands in the student's own town for every day of the year, and one clear day outside checks it.

Why a real reading is off: the Sun is about half a degree wide, so the tip of a shadow is fuzzy; a stick that leans, ground that slopes, a clock a few minutes out, or a time written without daylight saving all move the answer. The app counts a reading within 2 degrees of its own Sun's height as a match, about as close as a stick and a tape can get.

The cloudy-day plan

If there is no shadow, each student opens Measure a real shadow, fills in today's date, the time and the stick, and presses `Too cloudy today`. The app logs the day as cloudy and keeps its own prediction: how long the shadow would have been. Measure on the next sunny day.

Then use these two readings from a stick in Denver on October 15, 2026 (pick Denver in the Town list first, and put a 2026 date in the Day box):

READING	TIME ON THE CLOCK	STICK	SHADOW	WHAT THE APP SAYS
A	12:50 pm	100 cm	114 cm	A match: the Sun 41.3 degrees up from the shadow, 41.5 from the app (its shadow 112.9 cm)
B	12:00 pm	100 cm	140 cm	Off by 4.9 degrees: 35.5 from the shadow, 40.4 from the app

Ask what could have gone wrong with reading B: a stick leaning away from the Sun, or a shadow measured past the fuzzy edge.

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- When is the shadow shortest, and which way does it point then?
- Why do the noon marks move away from the stick through the fall?
- Why is sun noon in Denver at 12:53 pm on September 22 and not 12:00?
- Your reading was off by 3 degrees. Name two things that could cause it.
- Where will the noon mark be in late June?

> The last question is the real test: a student who says "close to the stick, the shortest of the year" has linked the shadow to the Sun's height through the seasons.

Cross-curricular extensions

- Math: from your stick and shadow, draw a right triangle to scale and measure the Sun's angle with a protractor.
- History: read how Eratosthenes used noon shadows in two cities to measure the size of Earth.
- Art: build a simple sundial and mark its hours against the app's hour marks.
- English: write instructions for measuring a shadow that a younger student could follow.

Vocabulary

Shadow stick	A straight stick standing upright on flat ground, used to follow the Sun by its shadow.
Sun noon	The moment the Sun is highest and the shadow is shortest. It is rarely 12:00 on the clock.
Sun's height	How many degrees the Sun is above the horizon. The lower the Sun, the longer the shadow.
Prediction	What you expect to find, written down before you look.
Daylight saving time	Clocks set one hour ahead from March to November, so sun noon comes about an hour later on the clock.

Differentiation

ENGLISH LEARNERS

- Keep the vocabulary slide up, and hold up a real stick and a tape measure as you say "stick" and "shadow".
- Group each learner with a partner who reads the dialog boxes aloud.
- Accept the shadow log as numbers and a sketch.

STUDENTS WITH IEPS OR 504 PLANS

- Give each group member one job: holding the stick, measuring, or writing the time.
- Zoom the browser to 150%.
- Allow three weeks of noon marks instead of six where the IEP allows a modified assignment.

STUDENTS WHO NEED MORE SUPPORT

- A sentence starter: "The shadow is shortest at ___ because the Sun is ___."
- Do the first real reading together at the front, typing it into the app on the projector.
- Measure in centimeters with the stick at 100 cm, so the numbers are easy to read.

STUDENTS READY FOR MORE

- Measure again on another day, a week or more later, and log both readings. What changed?
- Switch the level to High school and solve Find the town: work out a latitude from a noon shadow.
- Pick Honolulu and find the weeks when its noon shadow points south.

Adapting for other grades

Younger students: In grades 4 and 5 (5-ESS1-2, the length and direction of shadows), do the virtual stick and the real one, and skip the noon marks. Use Setup to turn off Tilt and Orbit and Sunlight. Drop the third rubric row; total 8, and 6 meets the objectives.

Older students: In high school, switch the level to High school: students work the Sun's height from their shadow with atan(stick / shadow), then the town's latitude from a noon shadow, and compare with a map.

Student worksheet

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/sunseasonslab?lesson=the-shadow-stick

Essential question: What can a stick's shadow tell us about the Sun and the seasons?

Warm-up: Where does a stick's shadow point at 9 am, at noon, at 4 pm? _____

1. **Vocabulary.** Shadow stick, sun noon, Sun's height, prediction, daylight saving time: write each in your own words.

2. **The virtual stick.** Denver, September 22: sun noon at _____, the noon shadow _____ m, pointing _____. The noon shadow five weeks later: _____ m.

3. **My real stick.** Day _____ Time _____ Stick _____ cm Shadow _____ cm. The app says _____ cm. A match? _____ (or: too cloudy, and the sample readings A and B)

1. Why does the noon shadow get longer from September to December?

2. Did your reading match the app? Name two things that could make a real reading differ.

Sun and Seasons Lab: The Shadow Stick

Exit ticket

Name: _____

1. A stick's shadow is shortest (A) at 12:00 on the clock (B) when the Sun is highest (C) just before sunset

2. From September to December in Denver, the noon shadow (A) gets longer (B) gets shorter (C) stays the same

3. Your real shadow was 3 degrees off the app. Name one thing that could cause it.

Sun and Seasons Lab: The Shadow Stick

Exit ticket

Name: _____

1. A stick's shadow is shortest (A) at 12:00 on the clock (B) when the Sun is highest (C) just before sunset

2. From September to December in Denver, the noon shadow (A) gets longer (B) gets shorter (C) stays the same

3. Your real shadow was 3 degrees off the app. Name one thing that could cause it.

Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	Sun noon, when the Sun is highest. In Denver on September 22 that is 12:53 pm on the clock.
2	A	The noon Sun gets lower toward the December solstice: 0.83 m on September 22, 1.97 m in late December.
3	Any one	A leaning stick, sloping ground, the wrong time or a time without daylight saving, or measuring past the middle of the fuzzy edge.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Virtual stick	Six weeks of noon shadows logged, with sun noon's clock time and the direction the shadow points.	Six weeks of noon shadows logged.	Fewer than six weeks.	No log.
Real stick	A real reading measured to the middle of the fuzzy edge, with the time, checked in the app, and a second reading on another day.	A real reading with the time, checked in the app (or a cloudy day logged and the sample reading checked).	A reading with no time, or not checked.	No reading.
Explanation	Explains the shortest shadow at sun noon, the growing noon shadow toward December from the lower Sun, and two reasons a reading can be off.	Explains the shortest shadow at sun noon and the growing noon shadow.	Explains one of the two.	No explanation.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The lesson is built for MS-ESS1-1, the seasons part: the Sun's height through the year, read from a shadow in a model and checked against a real one. Texas TEKS 112.26(b)(9)(A) is the grade 6 standard for the seasons (2021 adoption).

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
NGSS	**MS-ESS1-1**	6-8	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.	Students use the model to describe the pattern of the noon Sun's height through the fall from a shadow, and test the model against a real shadow.
Texas TEKS	**112.26(b)(9)(A)**	6	Model and illustrate how the tilted Earth revolves around the Sun, causing changes in seasons.	Students illustrate the changing Sun's height through the seasons with a model shadow stick and a real one.

Checked November 2026 against: NGSS MS-ESS1-1, Earth's Place in the Universe, NGSS MS-ESS1-1 evidence statement (June 2015), Texas Administrative Code, 19 TAC 112.26, Science, Grade 6, UMass Amherst Sunwheel, Lesson 5: measuring the Sun with a shadow stick through the year.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up.

To keep students' work, and see it all in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/sun-and-seasons-lab/lessons/the-shadow-stick/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time. The Sheet button in the app collects their predictions, readings, puzzles and written answers to hand in.

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