Sun Tracker Kit

AST-600

NGSS Correlations

5-ESS1 *Earth's Place in the Universe, Shadows*

"The orbits of Earth around the Sun... together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the Sun… at different times of the day, month, and year." (from 5-ESS1).

"Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows… " (from 5-ESS1-2)

Goals

- Engage students in grades K-8 in tracking the hourly, daily, and monthly movements of the Sun and its shadows.
- Students will learn how the shadows move as the Sun moves. They will make and record daily scientific observations.

Background

Every day, the Sun "moves" across the sky from East to West. It casts shadows that change during the day, during the month, and even during the year.

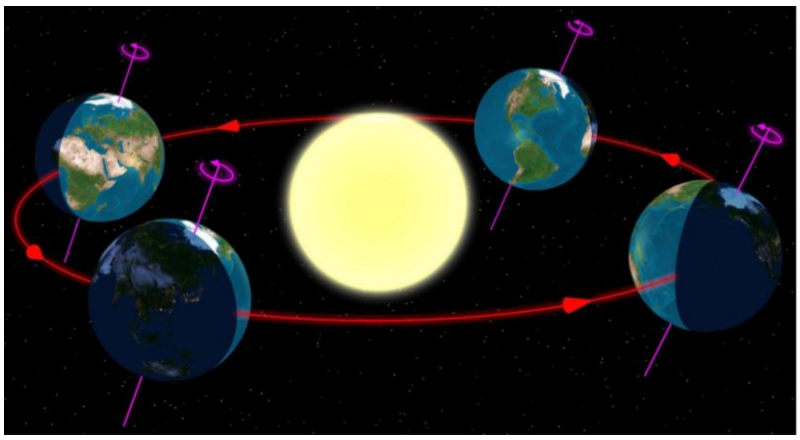
Actually, the Sun only *appears to move*. The Sun "moves" in the sky only because the Earth moves. We live on the Earth and we are carried under the Sun each day.

The Earth moves in two main ways that cause "observable patterns" in sunlight and shadow:

1. The Earth rotates about an axis that goes between its North and South poles. This is what causes day and night and makes shadows change hour-by-hour.

1. Earth rotating on its axis (showing axis pointing to the North Star)

2 The Earth travels in an orbit (an oval-shaped path through outer space) around the Sun. The orbit causes monthly and yearly changes to the Sun's motion and shadows.



2. Earth orbiting the Sun

Because of these two motions, the Sun follows a slightly different path through the sky each day. This path depends on what part of the year it is. In summer, it is a high path that causes short shadows. In winter, it is a low path that causes long shadows.

Each day, and each year, the motions of the Sun repeat.

Set up and requirements

A window. Find any window where the Sun shines through at some point during the day. This is a window that faces East, South, or West.

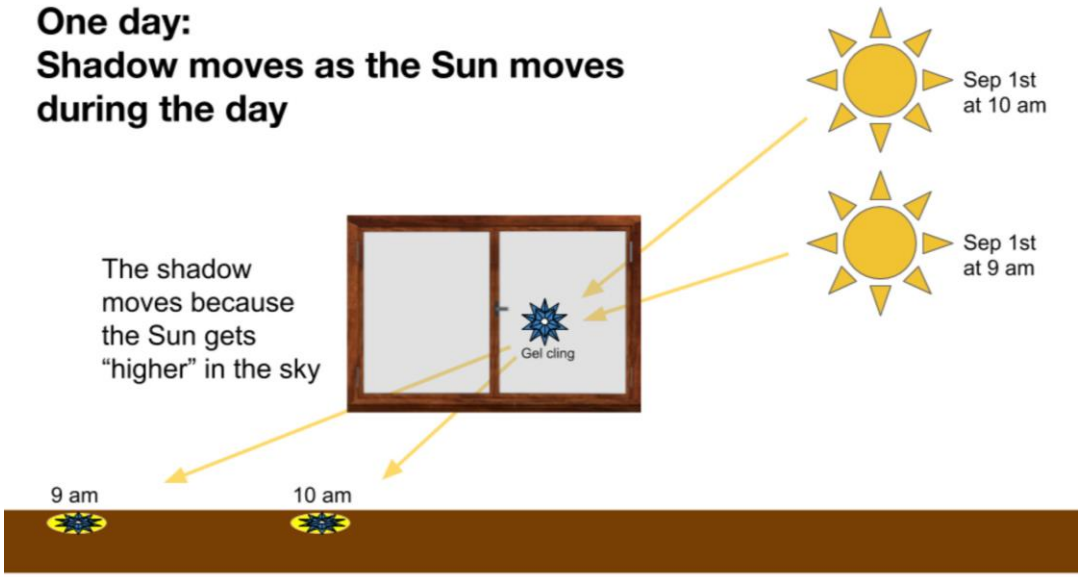
A floor or wall where the shadow will fall. The window should allow sunlight to shine through the gel cling clearly. The sunlight will shine through the gel cling onto a wall or floor and make a shadow. Place small, removable dot stickers to mark the position of this shadow each day.

Process

On a sunny day, find a sunny window. This can be any time of day during school time. You will be marking the Sun Tracker's shadow many times over the next months, so choosing a good starting time and place is important. This window could be in a classroom, a hallway, a gym, a lunchroom, a library or any other room with a sunny window.

Before taking the Sun Tracker gel cling out of the package, lift it up and place it against the sunny window. You can move it around all over the window to see where it casts its shadow. Ideally, the shadow will fall on a low (kid-level) wall, clear cabinet front, or a floor.

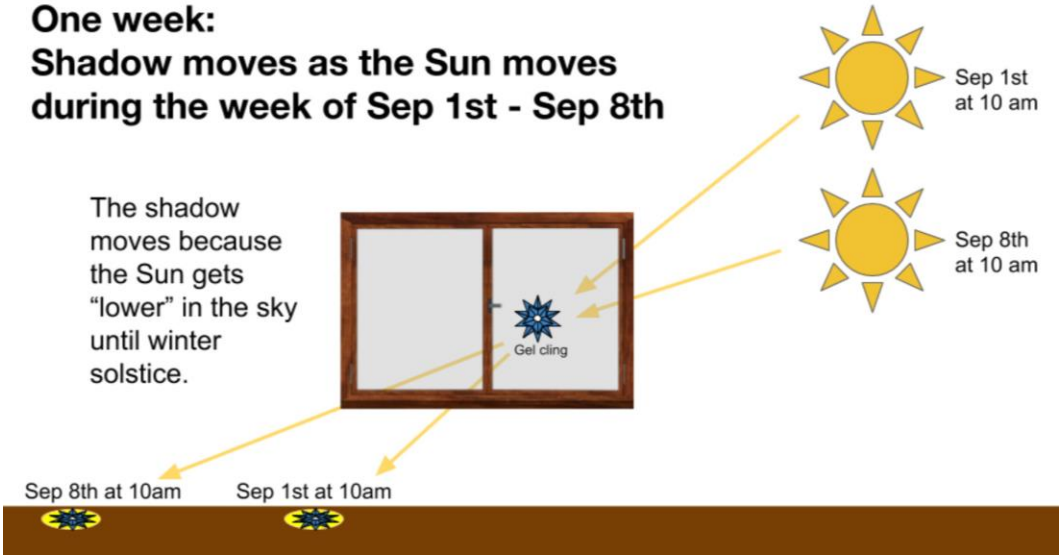
Place the Sun Tracker on the window. Ideally, it should remain in the same place during the entire year.



Basic

Each hour—starting in the morning, once per hour—place a sticker to mark the Sun Tracker shadow location. Notice how the shadow gets shorter (closer to the window) as the Sun goes higher. You can do this basic hour tracking every day!

It's a fun activity in itself, and it naturally leads into more advanced usage.



Advanced

Each day—at exactly the same time of day—place a sticker to mark where the shadow is. Notice how at the same time the next day, the Sun Tracker shadow has moved!

Make sure you write the date and time on the stickers. We need to record the times to be able to accurately track the day-by-day motion of the Sun.

If it is cloudy, just skip marking for the day.

Have the students guess where the Sun Tracker shadow will be the next day, the next week and the next month. Check back the next day, week and month to see if the guesses worked.

Refine these guesses into predictions after tracking the Sun's shadow for a few days. It's likely that after a few weeks the Sun Tracker shadow will move far away from the first marked point. It is likely to move so far that the shadow will no longer be "markable." This is perfectly normal! The Sun Tracker shadow will eventually return to the spot again. So keep tracking!

Prediction

Hour by hour motion: Before you start using the Sun Tracker, tell the students that you will mark the position of the Sun Tracker shadow now and then again in an hour. Have the students guess where the Sun Tracker shadow is going to be in an hour.

Day by day motion: Tell the students that they are going to track the position of the shadow every day. They should make a prediction about which direction the shadow will be at the same time tomorrow. Repeat this each day. As the markers get placed, a pattern will emerge. Each day the shadow moves to a new location! Even though it's the same time of day, the Sun shines from a slightly different place in the sky.

Tips for marking the Sun Tracker shadow

It's ok to place multiple stickers in one day, just make sure you write the date and time on them. We need to record the times to be able to accurately track the day-by-day motion of the Sun. In fact, if you can't see the Sun at every moment because of clouds, sometimes it can help to mark the Sun Tracker's shadow a few times on the same date. This can help fill in any gaps.

You should set up an alarm (on a smartboard, computer, or phone) to remind you to mark the Sun's position each day.

Tips for "seeing" where the shadow is

It can help if one student or the teacher moves their finger nearby the Sun Tracker gel cling. This will cast another shadow that moves and makes the Sun Tracker shadow easier to see. Place the Sun Tracker stickers in the center of the shadow.

Tips for the initial choice of window/wall choice and window cling placement

The window you choose should get sunlight at some time during the school day. You can try different windows by using multiple Sun Trackers.

Start the activity at any time of day or year. If you are using the Sun Tracker during Sept 21, Dec 21, March 21, or June 21, you can use it to mark the significant way points for the Sun's motion: the two equinoxes and two solstices. The Sun "moves" more during the equinox months, and less during the solstice months.

Sunrise and sunset times change almost 3 hours over the year! So, as you pick where the Sun Tracker will be placed, keep in mind that it can go "out of range." That's okay! When the Sun Tracker shadow moves really far from where it started it makes a big impression.

Tip if you are using this in the Southern hemisphere

Choose a window that faces North, East, or West. South-facing windows won't get any sunshine.

Explanation - The Science behind the Sun Tracker

Tracking the Sun's motion hour by hour.

Let's talk about daily rotation of the Earth! Here are some science facts we will learn and observe with our own measurements:

- The Earth rotates once per day. Rotate means we face towards the Sun (day) then we slowly turn away from the Sun (sunset), then we keep turning (night) until we face the Sun again (sunrise). This repeats every day!

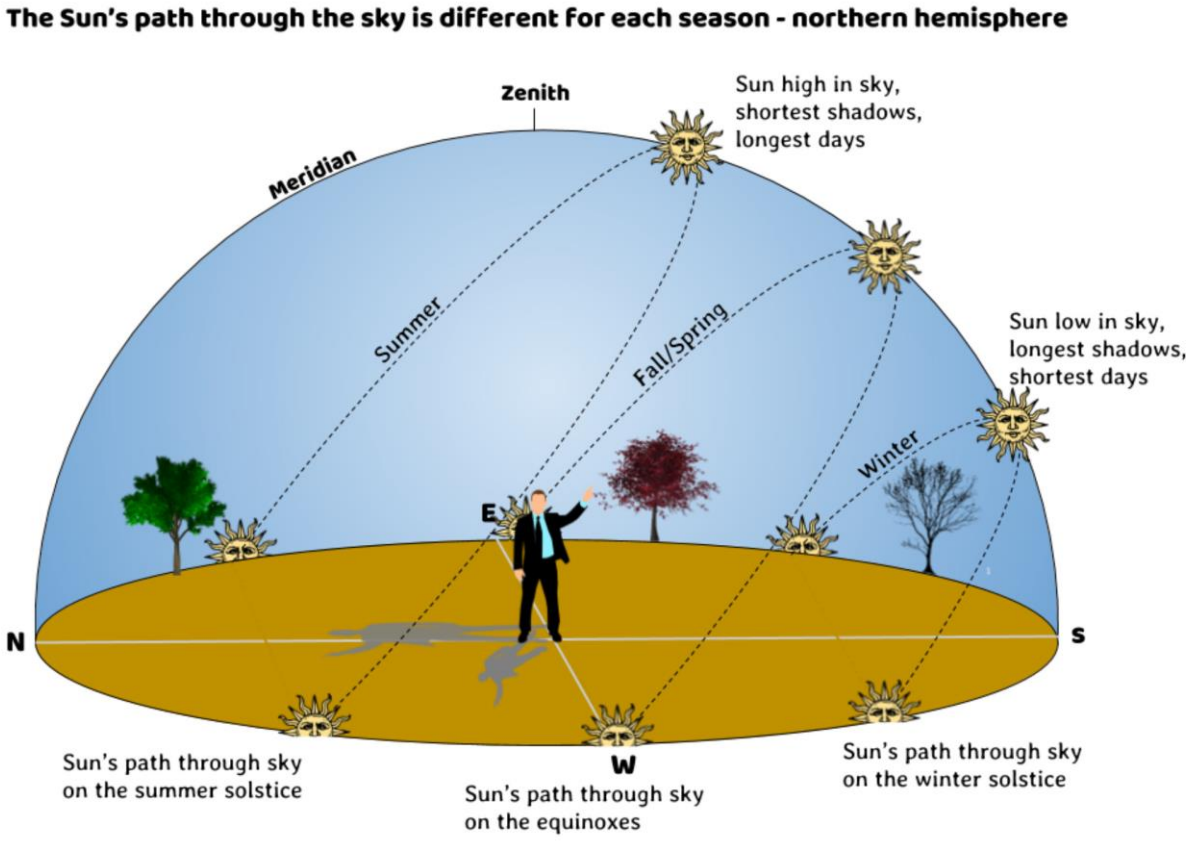
- Every hour of every day and night the Earth carries people at the equator 1000 miles (1600 km)! Around New York this is about 760 miles per hour (the farther from the equator, the slower you go). So, if we are in New York, in 24 hours the Earth carries us 24*760 = 18,240 miles!
- Part of that time we travel under the Sun and the Sun shines on us (this is called day).
- The Earth carries us eastward, so the Sun appears to rise in the East and travel West.
    - You can have the kids "see" this by having them face towards a light (this will be the Sun) then turn to the right until they can just still see the light out of the left side of their vision - this is sunrise.
    - Now, have them turn left until they are facing the light again—this is noon.
    - Then keep turning left until the light is only visible out of the right side of their vision—this is sunset.)
- The Sun makes shadows that change during the day.
    - In the morning, they are long.
    - At noon, they are shortest.
    - In the afternoon, they grow longer again.

Tracking the Sun's motion day by day.

Let's talk about yearly orbit of the Earth! Here are some science facts we will learn and observe with our own measurements:

- The Earth rotates once per day. Each day the Earth moves a little bit along on the orbital path around the Sun.
- The Earth orbits the Sun once per year. Orbit means we travel in a large roughly-circular pathway around the Sun.
- Every day, the Earth moves a little bit farther along on that giant pathway (orbit) - 1.6 million miles (2.57million km) per day.
- It takes three months to go a quarter of the way around the Sun, six months to go halfway around the Sun, and 12 months to go all the way around the Sun.
- The Earth's daily rotation carries us "toward the dawn" (Eastward) once each day. At the same time, the Earth's orbit carries us "toward the dawn" bit by bit, day after day—the Earth (as seen from above the North Pole) orbits counter-clockwise (Eastward).

- The orbit combined with the tilt of the Earth changes the Sun's daily path across the sky.
    - The Sun moves on a path through the sky during the day. As the Earth moves on its orbit around the Sun, the path of the Sun changes.
    - The Earth's daily rotation is on a tilt with the axis aligned with the North Star.
    - As the Earth travels the orbital path around the Sun, the tilted axis stays pointed at the North Star, so over the course of a year, the part of the Earth that is facing the Sun during the day changes from the Northern hemisphere to the Southern hemisphere and back again.
    - If we experience day while our hemisphere is tilting toward the Sun, it makes the Sun appear higher in the sky (summer).
    - If we experience day while our hemisphere is tilting away from the Sun, it makes the Sun appear lower in the sky (winter).



Tracking the daily rotation combined with the orbit

These two motions together (with the tilt of the Earth) explain everything about the Sun Tracker results.

Vocabulary

AXIS: The center "pole" of a spinning object.

DATE: Labels for days, months, and years. Dates are how we talk about which day it is.

EARTH: Where we live. It's a ball-shaped planet that rotates on its own axis and orbits the Sun. These two movements are what causes days (rotation) and years (orbit).

ORBIT: A (roughly circular) path that an object follows around another larger object.

OUTER SPACE: A region of space that is not part of the Earth or another object in space.

ROTATION: The daily motion of the Earth. It spins counter clockwise on its polar axis.

SHADOW: A darkened area some distance away from an object and a light source. A solid object blocks a light source and causes a shadow. Usually the shadow is the same shape as the solid object.

SUN: A ball of hot gas that forms the center of gravity in our solar system. All the planets orbit the Sun. Because the Earth orbits the Sun, from the Earth, we see the main motion of the Sun as East to West. However, (over weeks and months) the Sun also appears to move North and South.

TIME: Labels for moments. Time is a way of naming motion.

Follow-up activities

Sundial: The Sun Tracker is like a giant, immersive sundial. Essentially, your students are "inside" the sundial and experience the shadows. You can track the shadows of a tall pole or building to bring the activity outside. Or you can do it with a paper plate and a stick. Mark the times where the shadow falls.

Diorama: A Sun Tracker diorama can be easily made using a paper plate and showing a 3D path of the Sun. This is a fun extension idea for middle school.

Time zones: Let's talk about time zones! The students will learn that not everyone experiences the same time of day at the same time. They will learn that time of day depends on *where you are on the Earth.*

Winter and summer solstice: If you are marking the Sun's movement during the winter or summer solstice, you will notice that the Sun seems to stand still over a few days. This is the meaning of the word "solstice"—Sun standstill!

The Analemma. If the data on the Sun Tracker shadow position is recorded very carefully, and completed for an entire year, the resulting pattern of shadow points will be an elongated figure eight shape. This shape is known as the Analemma. It is visible on most Earth globes, usually printed somewhere on the Pacific Ocean.

References

https://www.nextgenscience.org/dci-arrangement/5-ess1-earths-place-universe

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