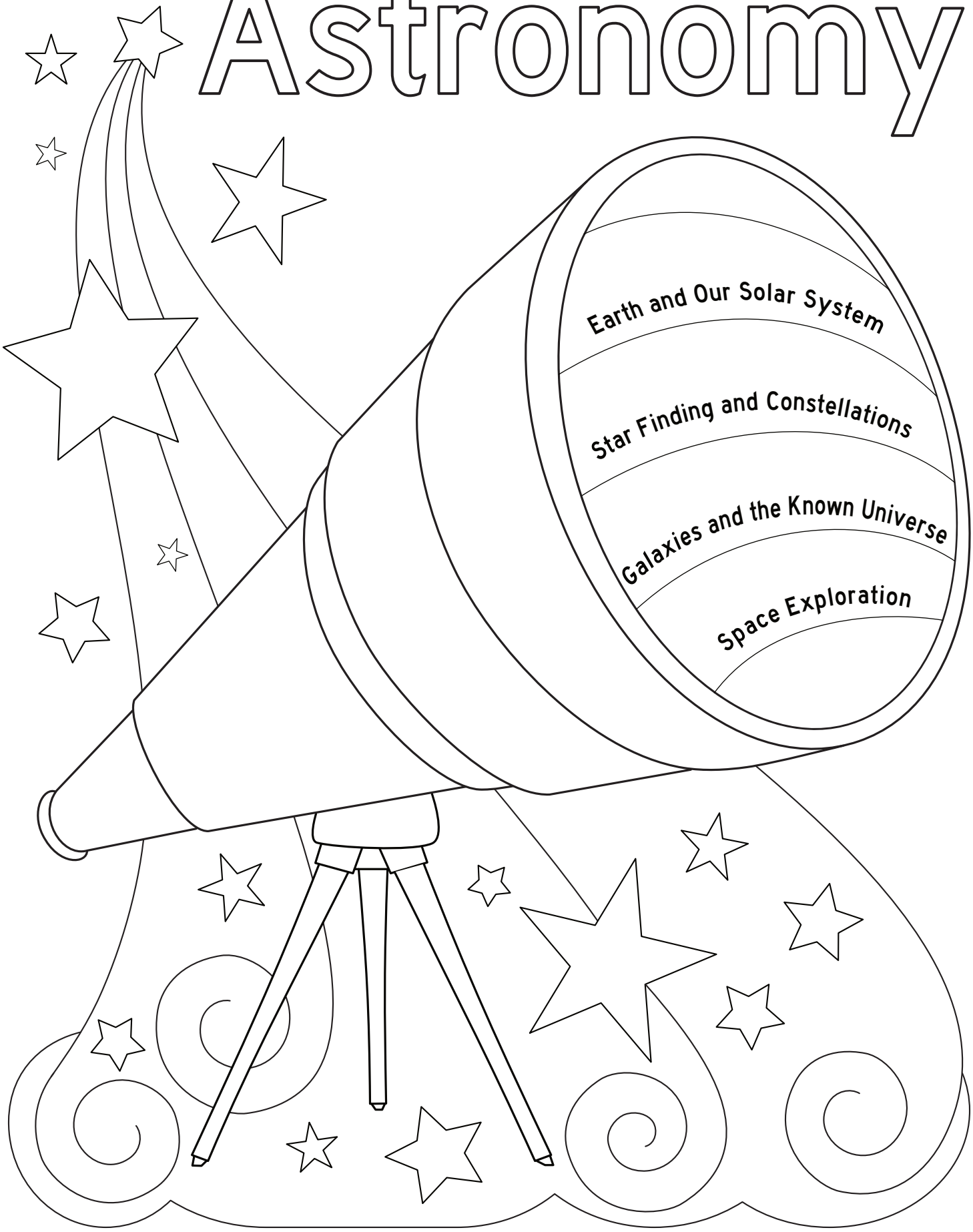
Astronomy


Earth and Our Solar System
Star Finding and Constellations
Galaxies and the Known Universe
Space Exploration

ASTRONOMY

Supply List:

Lesson 3 - Measure Your Latitude
- Thread or string (about 15 cm long)
- Printable protractor OR standard protractor
- Pin OR a needle or nail
- Washer OR small object that can hang from string
- Straw
- Tape and a tape measure

Lesson 6 - DIY Equatorial Sundial
- Inclinometer (made in lesson 3)
- Wooden Dowel
- Drill
- Cardboard or wood
- Sundial template
- Scissors

Lesson 8 - Make a Model of Earth & the Moon
- Dough OR modeling clay
- Ruler (optional)

Lesson 9 - Cookie Models and Journal
- Moon journal printout
- Binoculars (optional)
- Cookie and cream style sandwich cookies (optional)

Lesson 15 - Step Scale Model of Solar System
- Chalk or something else that can be used to mark position in an outdoor location
- Planet template OR modeling clay
- Yardstick or tape measurer (optional)

Lesson 18 - Ellipses and Orbits
- Thread OR string
- 2 pushpins OR small nails
- Marker OR pen
- Flat piece(s) of cardboard

Lesson 21 - Flour and Cocoa Craters
- 2 balls of different sizes such as small / large marbles
- Flour
- Cocoa powder
- Ruler
- A wide non-breakable container

Lesson 26 - Stargazing
- Outdoor location
- Warm clothing
- Binoculars or telescope (optional)
- Red flashlight (or light covered with something red)
- Stargazing printouts or paper and pencil

Lesson 29 - Solar Updraft Tower
- Paper (in both black and white colors)
- 2 wooden skewers
- Scissors
- Tape
- 2 needles OR 2 nails
- Modeling clay
- Thermometer
- Sunny window OR a heat lamp

Lesson 32 - Star Classification Poster
- Poster board or a large piece of paper
- Art supplies such as markers, crayons, or paint
- Objects to represent stars that are different sizes and colors such as:
  - *Paper stars. use scissors to cut different colors of construction paper to different sizes*
  - *Balloon stars: inflate different-color balloons to different sizes*
  - *Papier-mâché stars: use a variety of bowls as molds to make hemispheres of different sizes*

Lesson 35 - Make a Constellation Viewer
- Cylindrical cardboard container
- Constellation printout
- Nail or pin
- Phone (with a flashlight)

Lesson 41 - Candybar Heat Shield
- 4 paper cups
- Tongs
- Small candy bars
- Construction materials such as cotton balls, steel wool, newspaper, cardboard, or aluminum foil
- Electrical tape
- Hair dryer

Unit 1: Earth & the Moon

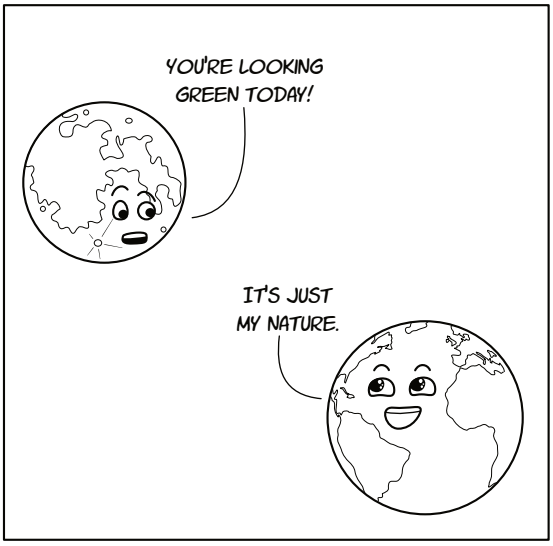
Words are more than tools for communication, they are the framework of knowledge! Without language to express and define new ideas, we wouldn't be able to learn.

To understand astronomy, it's essential to have the right **vocabulary**. The words you see on these pages are terms we will be using in our Earth and Moon unit.

Are you already familiar with some of these terms? If so, match them with the correct vocab cards.

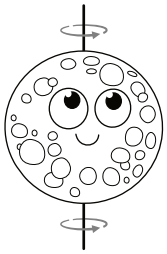
If there are terms or words you don't know, don't worry! We'll be learning them in future lessons. As you learn new concepts, come back to these pages and label each card.

You can also become more familiar with these words by using flashcards or playing memory. The appendix has a printer-friendly set of all of the vocabulary terms.

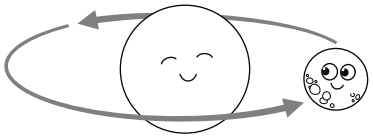


APHELION DIURNAL MOTION ECLIPSE ECLIPTIC EQUATOR
HEMISPHERE HORIZON LATITUDE LONGITUDE ORBIT
PERIHELION PRIME MERIDIAN REVOLVE ROTATE ZENITH

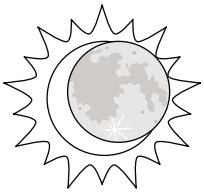
TO SPIN AROUND AN AXIS OR CENTER



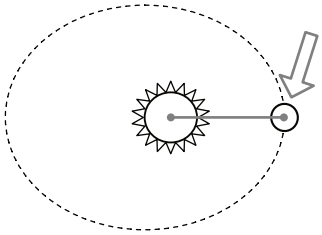
TO MOVE IN A CIRCULAR PATH AROUND AN OBJECT; TO ORBIT AROUND SOMETHING



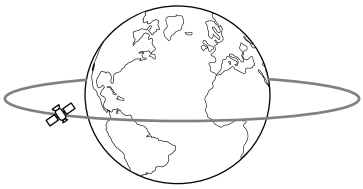
WHEN ONE OBJECT PASSES IN FRONT OF ANOTHER; WHEN ONE OBJECT PARTIALLY OR TOTALLY BLOCKS THE VIEW OF ANOTHER OBJECT



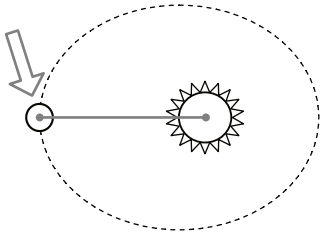
THE POINT WHERE AN ORBITING OBJECT IS CLOSEST TO THE SUN



THE CURVED PATH AN OBJECT TAKES AROUND A STAR, PLANET, OR MOON

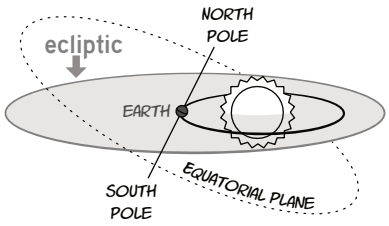


THE POINT WHERE AN ORBITING OBJECT IS FURTHEST FROM THE SUN



A LINE FROM NORTH TO SOUTH POLE THAT PASSES THROUGH GREENWICH, ENGLAND

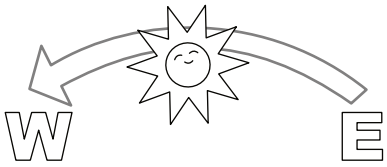
THE APPARENT PATH OF THE SUN ACROSS THE SKY OVER A YEAR



A LINE AROUND THE EARTH THAT IS EQUALLY DISTANT FROM THE NORTH / SOUTH POLES.

PARALLEL LINES THAT MEASURE DISTANCE FROM THE EQUATOR

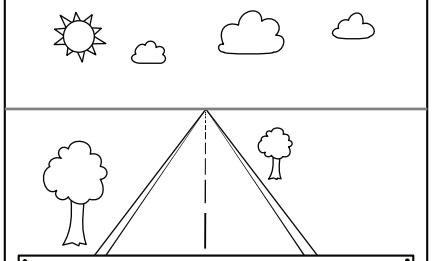
THE REPEATED DAILY MOVEMENT OF STARS AND OTHER OBJECTS ACROSS EARTH'S SKY FROM EAST TO WEST



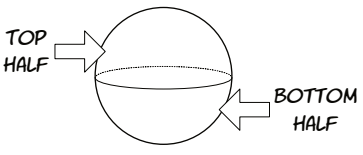
LINES THAT MEASURE DISTANCE FROM THE PRIME MERIDIAN

THE POINT IN THE SKY THAT IS DIRECTLY ABOVE THE OBSERVER

THE LINE WHERE THE SKY AND EARTH APPEAR TO MEET



HALF OF A SPHERE



What is Astronomy?

People sometimes confuse astronomy and astrology. These two fields share a common history, but today they are very different!

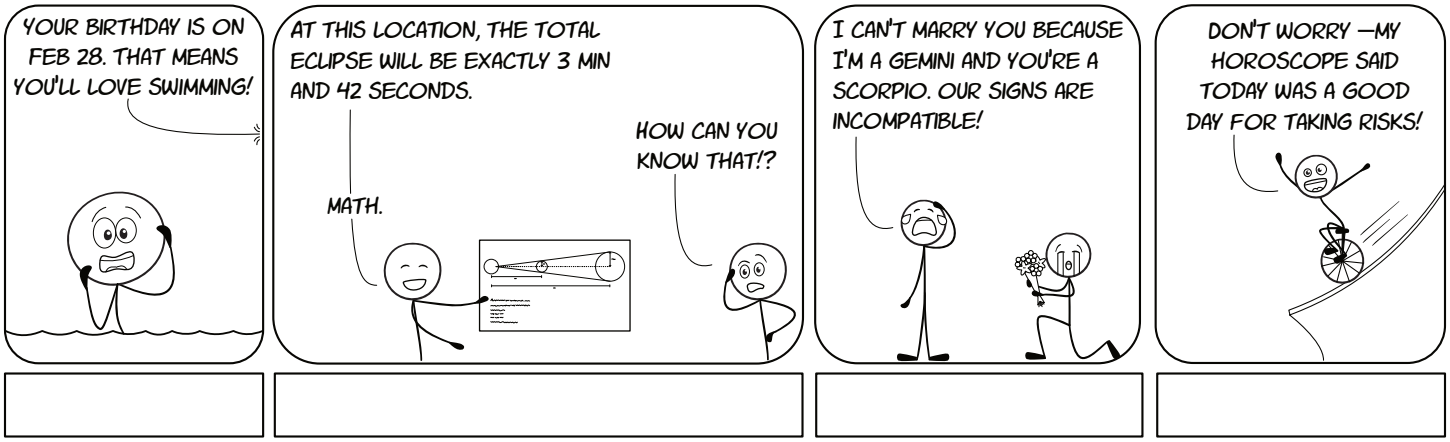
Astronomy is: _____

_____

Astrology is: _____

_____

IS IT ASTRONOMY OR ASTROLOGY? Label each scenario below:



IS IT SCIENCE OR PSEUDOSCIENCE?

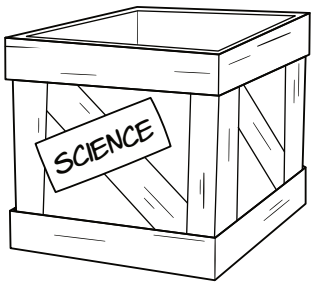
Match each characteristic with the appropriate box

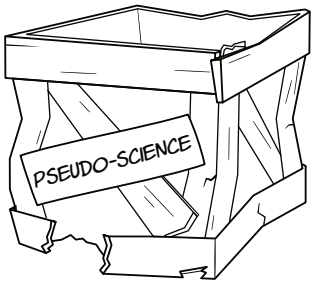
Relies on anecdotal evidence

Relies on data, controlled studies, and reproducible observations

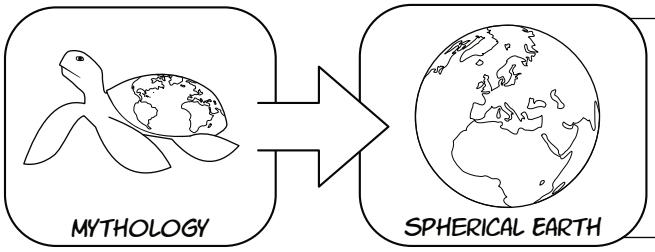
Responds to contradictions & criticism by gathering additional data or revising ideas

Responds to contradictions & criticism with denial, antagonism, or conspiracy theories





Concepts of Earth through Human History

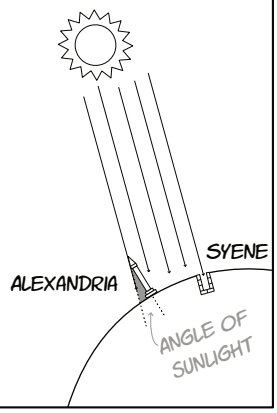


In ancient times, many cultures had mythology depicting the Earth as being flat or being part of a giant tree or on the back of a large animal.

Using reason and mathematics, Greek philosophers proved the Earth was spherical. Some of them also recognized that Earth behaved like the other planets and orbited the Sun.

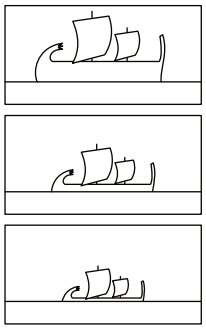
Aristotle
approximately 350 BCE

Eratosthenes
approximately 250 BCE

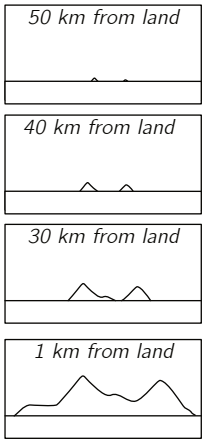


Ptolemy
approximately 150 CE

A SHIP DISAPPEARS HULL-FIRST WHEN IT SAILS OVER THE HORIZON



LAND APPEARS "TOP FIRST" WHEN COMING HOME FROM SEA

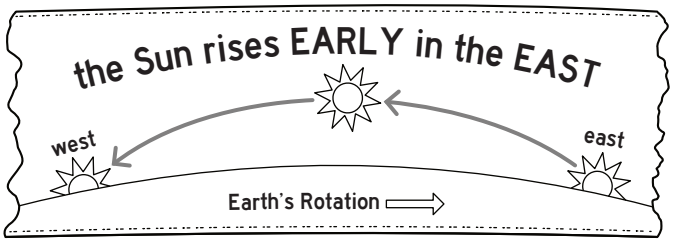


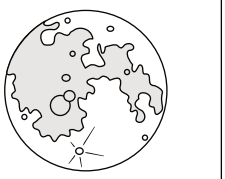
Our Current View of Earth:

Diurnal Motion: resulting from the rotation of the Earth

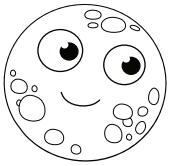
From the perspective of an observer on Earth, the Sun moves in an arc across the sky each day from east to west.

What other objects follow a similar path through the sky? Put a checkmark by all that apply:

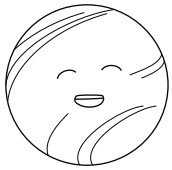




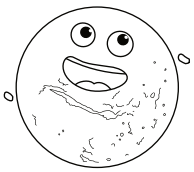
☐ **Moon**



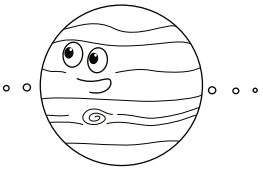
☐ **Mercury**



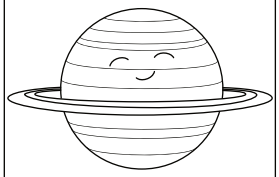
☐ **Venus**



☐ **Mars**

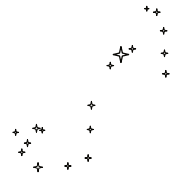


☐ **Jupiter**

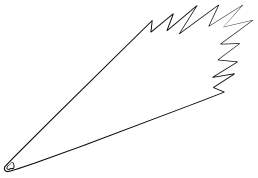


☐ **Saturn**

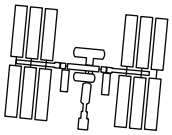
A BRIGHT STAR FOUND IN THE CONSTELLATION SCORPIUS



☐ **Antares**



☐ **Halley's Comet**



☐ **The ISS**

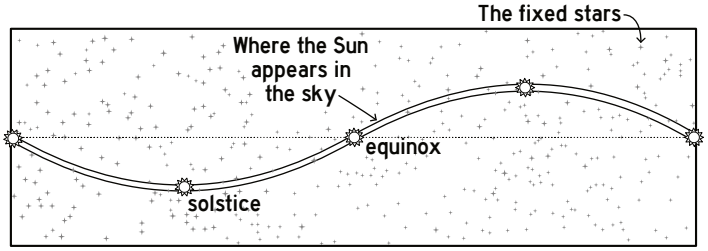
Also called the "North Star"

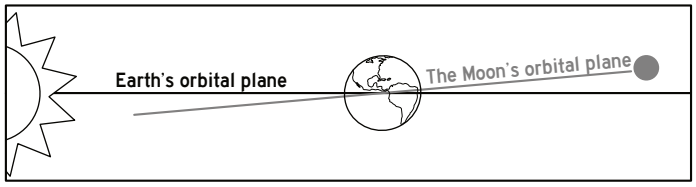
☐ **Polaris**

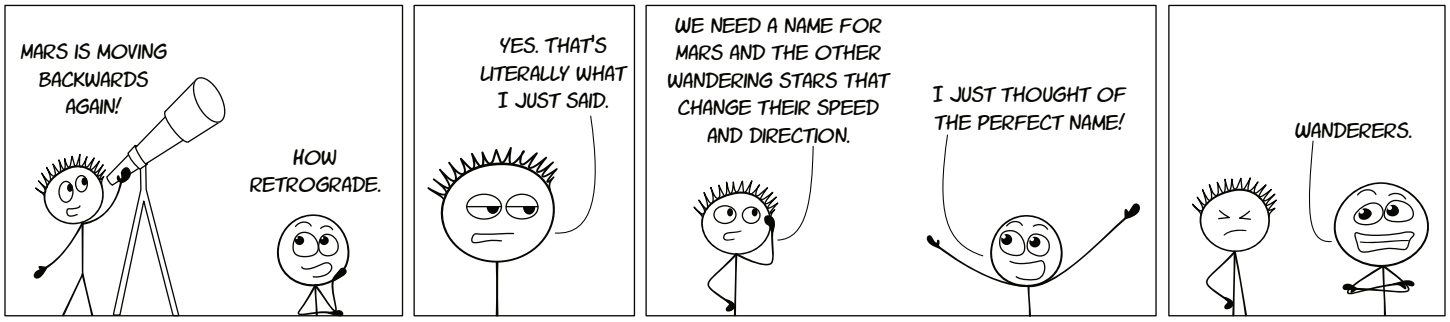
Over the course of a year, the Sun appears to travel through the fixed stars, tracing a path called the **ecliptic**.

Early Greek astronomers named this line the *ecliptic* (Greek for "fail to appear") because it was the only place where eclipses occurred.

Another way to think about the ecliptic is from the perspective of an observer in outer space. In this case, the ecliptic is the plane of Earth's orbit around the Sun.



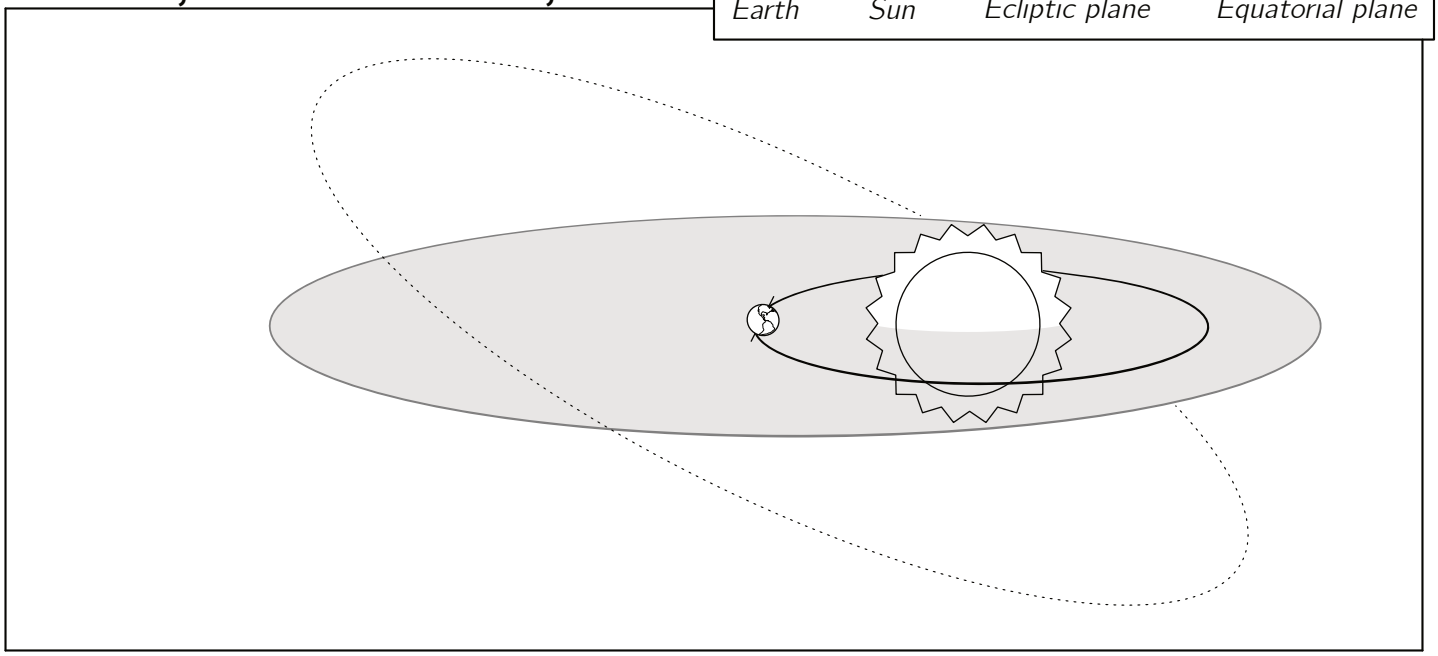




The English word "planet" comes from the Greek word planētēs which means "wanderer."

Label the diagram below with the following terms:

Earth	*Sun*	*Ecliptic plane*	*Equatorial plane*



The poles, equator, lines of latitude, and lines of longitude are all defined in relation to how our planet **rotates**. Rotating is different than revolving!

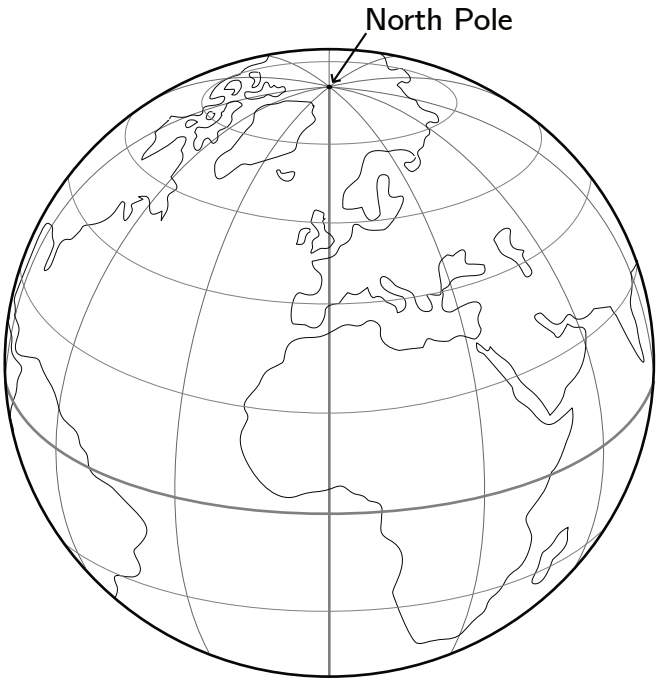
Define these terms and describe how long it takes the Earth to complete one of each:

Rotation:_____

Revolution:_____

Label the term for each definition and then identify them on the globe:

The first one has been done as an example

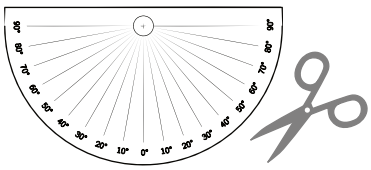


Pole (North or South Pole)
A point aligned with Earth's axis of rotation, or a point around which all the stars appear to rotate.
A line around the Earth that is equidistant from each pole. A circle that divides a sphere into northern and southern hemispheres.
Parallel lines that measure distance from the equator.
A line from the North Pole to the South Pole that passes through Greenwich, England.
Lines that measure distance from the prime meridian.

Measure Your Latitude

MATERIALS

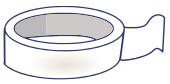
~15 cm of thread or string



Protractor template and scissors OR a standard protractor

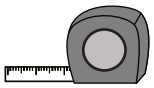
Pin

Washer or other weight



Tape

1 straw



Tape measurer

GOALS

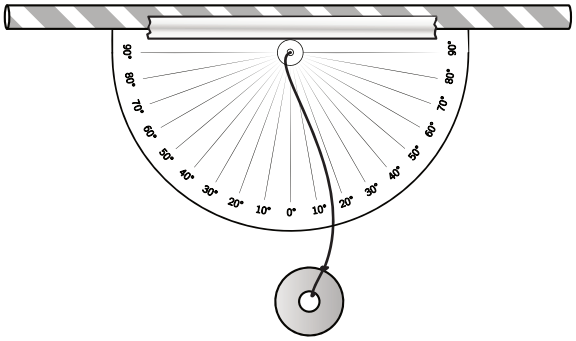
- Build a device to measure the angle of incline of a distant object.
- Find the latitude of your current location.

Purpose of an inclinometer

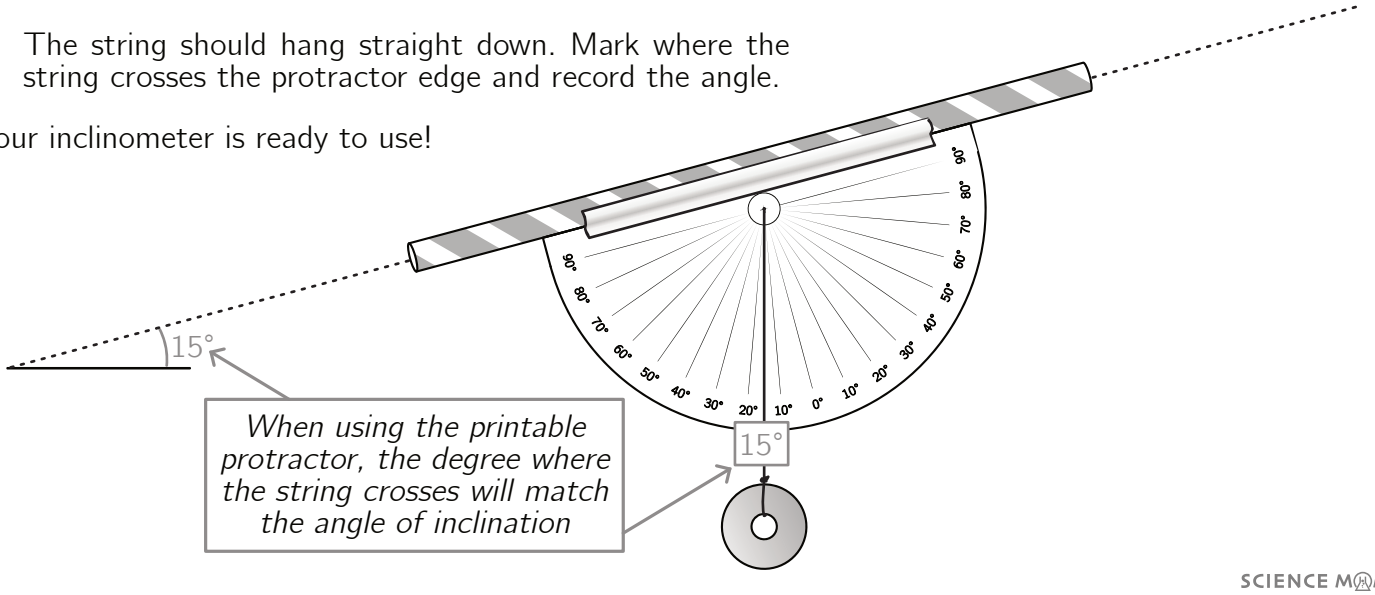
An inclinometer (sometimes called clinometer) is a tool that helps you to measure the angle or inclination of an object. With a little bit of geometry, inclinometers can be used to find the height of an object or the latitude of a person's current location.

How to make an inclinometer:

1. Use the protractor template from the appendix to make a printable protractor OR use a standard protractor. If using the printable version, be sure to cut it out carefully so that you get a straight edge on top. If necessary, glue it to cardstock or cardboard to make it more sturdy.
2. Use a pin to poke a hole in the center of the protractor template on the plus sign.
3. Feed some of the the string through the hole and tape it in place on the back. If using a standard protractor, tape the string so that it hangs freely.
4. Tie the washer to the other end of the string.
5. Tape the straight edge of the protractor to the straw.
6. To use the inclinometer, close one eye and look at your target through the straw. Carefully adjust the angle so that you can see the target in the center of the straw.
7. The string should hang straight down. Mark where the string crosses the protractor edge and record the angle.

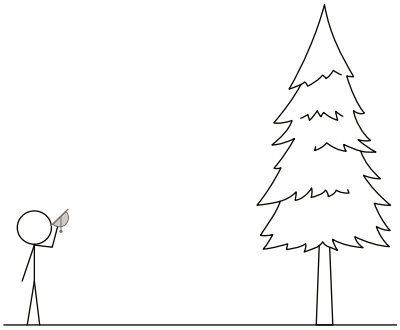


Your inclinometer is ready to use!



How tall is it?

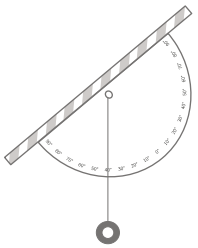
Before finding our latitude, it's important to understand how an inclinometer works by using it to find the height of an object.



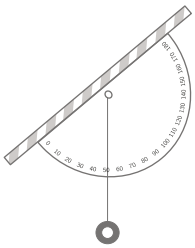
1. Choose a tall object such as a tree, flagpole, or building that is located on flat ground.
2. Have a person (the observer) stand so that they have a clear line of sight to the object.
3. The observer should look through the straw of the inclinometer and hold it so that the top of the object is visible through the center of the straw.
4. Note where the string is hanging and record where it crosses the curved edge of the protractor. Record the angle.
   - *If using the **printable protractor,** record the number seen where the string crosses the edge.*
   - *If using a **standard protractor**, subtract the angle measured on the protractor from 90°. This is your angle of inclination.*
5. Measure the horizontal distance from observer to object.
6. Measure the eye height of the observer.
7. Now that you have both the angle and horizontal distance of a triangle, you can use trigonometry to find the length of the side opposite the angle. This distance (labeled x) is from the eye height of the observer to the top of the object. Use your angle and horizontal distance to find the value of x:

   x = tangent(angle of inclination) · horizontal distance

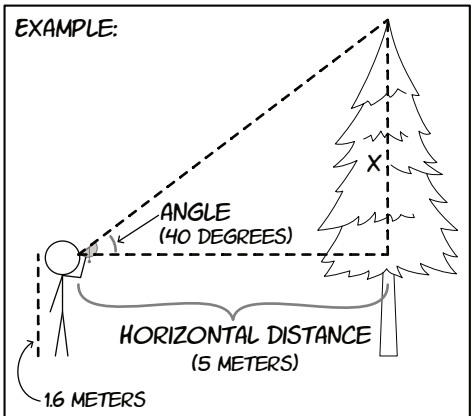
8. Add the height of the observer to x to find the total height of the object.



PRINTABLE PROTRACTOR
Angle of inclination: 40°



STANDARD PROTRACTOR
Angle of inclination:
90°-50° = 40°



x = tan(40°)·5
x = 4.2 meters
Tree height = 4.2 + 1.6 = **5.8 meters**

What object did you choose to measure? How tall do you think it is? Before using the inclinometer, make a guess! What do you estimate for the height of the object?

Object: _____

Estimated height before measuring: _____

Horizontal distance (observer to object): _____

Eye level height of observer: _____

Angle of inclination: _____

Calculated height of the object: ☐

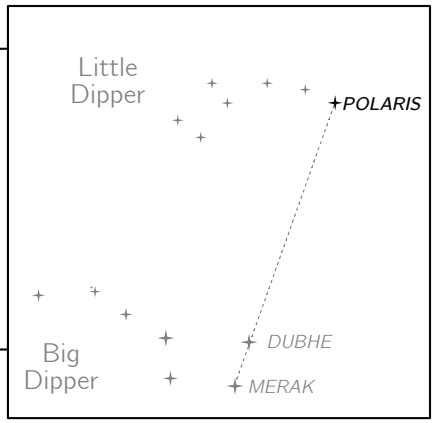
x = tangent(angle of inclination)·horizontal distance

x + eye level height of observer = object height

Finding Your Pole Star: Northern Hemisphere

Locate Polaris (the North Star) by using an app such as Sky Guide or by using the asterism called the Big Dipper. The stars Merak and Dubhe in the Big Dipper point directly toward Polaris, which is the end of the "handle" in the Little Dipper.

To find your latitude with the inclinometer, look at Polaris through the straw. Hold the inclinometer steady with the string hanging freely down. Note where the string crosses the curved edge of the protractor.



Finding Your Pole Star: Southern Hemisphere

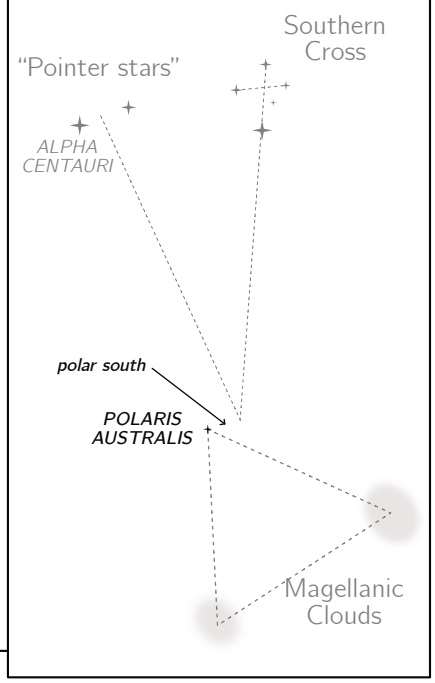
Use the inclinometer to find your latitude by locating Sigma Octantis (also called Polaris Australis or the Southern Star). It is not located exactly over polar south, but it's close! You can use an app such as Sky Guide or find it by using one of these approaches:

1. Southern Cross + 4 Lengths: Find the Southern Cross. Notice the length between the stars that form the "long" end of the cross. Polaris Australis is approximately 4 of these lengths away along the same line.

2. The "Pointer Stars" and the Southern Cross: The two brightest stars in the constellation Centaurus are near the Southern Cross. A line perpendicular to those stars can be used to intersect a line from the Southern Cross. Polaris Australis is very close to this intersection.

3. Magellanic Cloud Triangle: The large and small Magellanic clouds are two nearby galaxies that are visible as hazy spots in a dark night sky (similar in appearance to the hazy light of the Milky Way). A nearly equilateral triangle can be drawn between these and Polaris Australis.

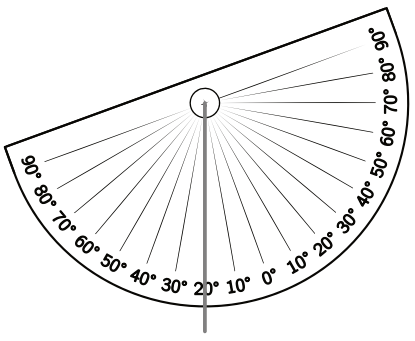
To find your latitude with the inclinometer, look at Polaris Australis, through your straw. Hold the inclinometer steady with the string hanging freely down. Note where the string crosses the edge of the protractor.



The **printable protractor** has angles labeled with 90°−x. Where the string crosses the edge will match the protractor's ***angle of inclination***.

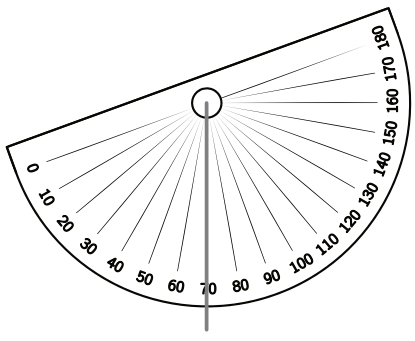
If using a **standard protractor**, take the angle where the string crosses the edge and then subtract it from 90°. Now you have found the ***angle of inclination***.

EXAMPLE WITH PRINTABLE PROTRACTOR:



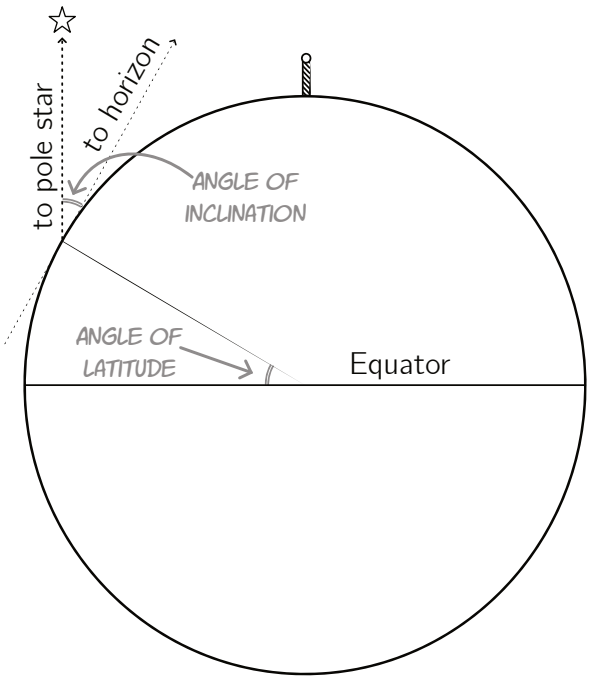
The string crosses at 20°, so the angle of inclination to the pole star and latitude are also 20°. If in the Northern Hemisphere, the latitude would be 20° North. In the Southern Hemisphere, the latitude would be 20° South.

EXAMPLE WITH STANDARD PROTRACTOR:



The string crosses at 70°, so the angle of inclination is 90°-70°= 20°. If in the Northern Hemisphere, the measured latitude would be 20° North. If in the Southern Hemisphere, the latitude would be 20° South.

1. Why should the angle of inclination to the pole star be equal to an observer's latitude on Earth? Use the diagram if it is helpful to your answer.

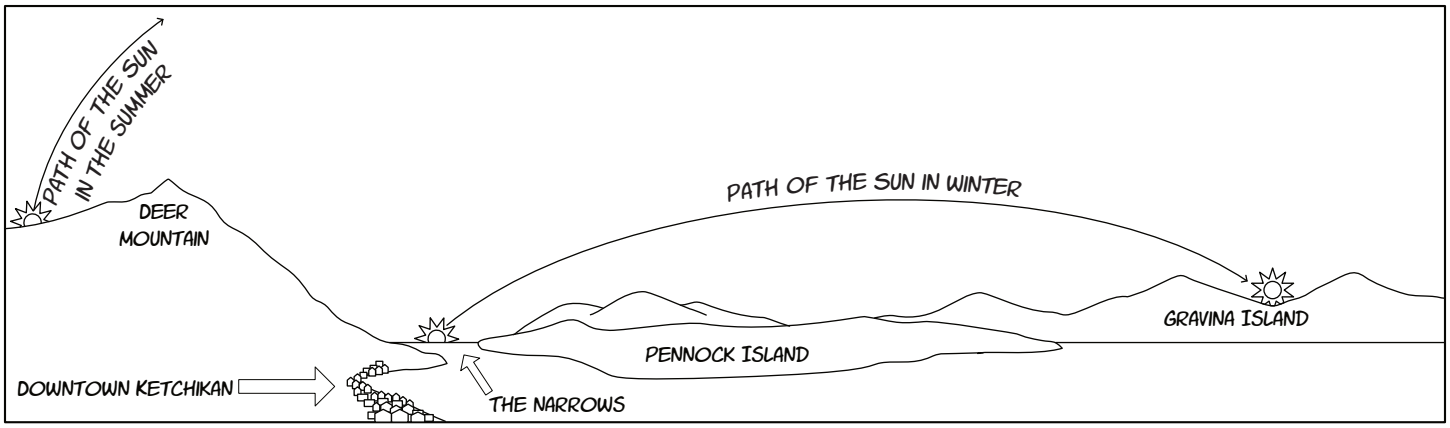


2. At your location, what angle of inclination did you observe when sighting the pole star (Polaris or Polaris Australis)?

3. Look up your actual latitude. Did the angle of inclination match your latitude? If not, what do you caused the difference?

4. Siti lives on a small island in Indonesia located very close to the equator. Will she be able to use an inclinometer to find her latitude? Why or why not?

THE SEASONS: caused by Earth's axial tilt



During the winter in Ketchikan, Alaska, we watch the Sun rise over the Tongass Narrows. Sunset occurs over Gravina Island directly in front of our window. The Sun is low in the sky all day and never shines in our backyard.

During the summer, the Sun rises on the back side of Deer Mountain and our backyard has hours of sunshine. In the summer evenings, we can't see the sunset from our house. It's far to the right behind houses and mountains!

What seasonal differences in the position of the Sun have you observed where you live? When and where does the Sun rise and set? Where is the Sun in the sky at noon?

During winter: _____

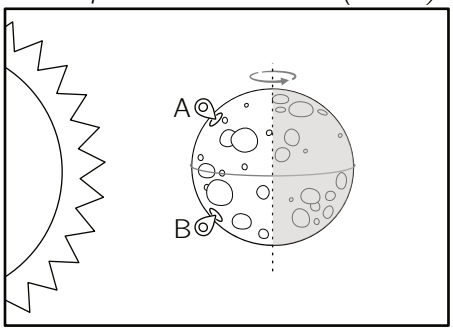
_____

During summer: _____

_____

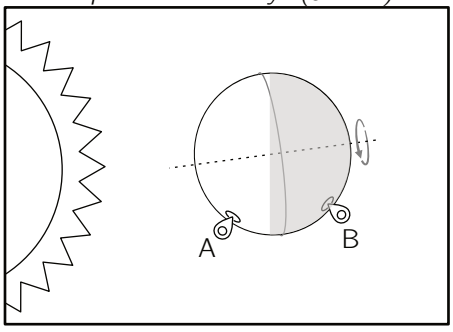
How much sunlight in 1 day?

Tilt of planet = almost none (0.027°)



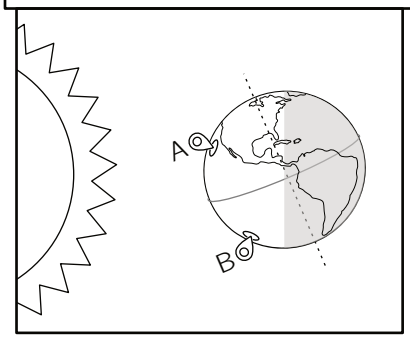
A planet with almost no tilt undergoes 1 complete rotation in 24 hours. During that time, will point A receive more, less, or the same amount of sunlight as point B? Point A and B are the same distance away from the equator.

Tilt of planet = sideways (97.77°)



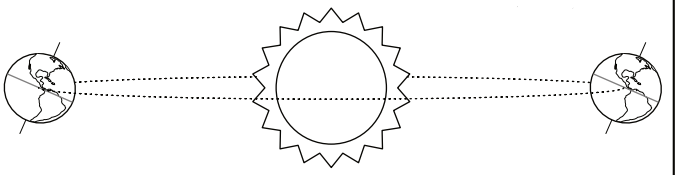
A planet with an extreme tilt of 97° undergoes 1 complete rotation in 24 hours. During that time, will point A receive more, less, or the same amount of sunlight as point B? Points A and B are the same distance away from the equator.

Earth is tilted at 23.5 degrees



Earth has a tilt of 23.5° and completes 1 rotation every 23 hours and 56 minutes. During that time, will point A receive more, less, or the same amount of sunlight as point B? Point A and B are the same distance away from the equator.

Solstice



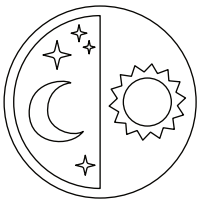
DEFINITION: _____

_____

_____

_____

Equinox



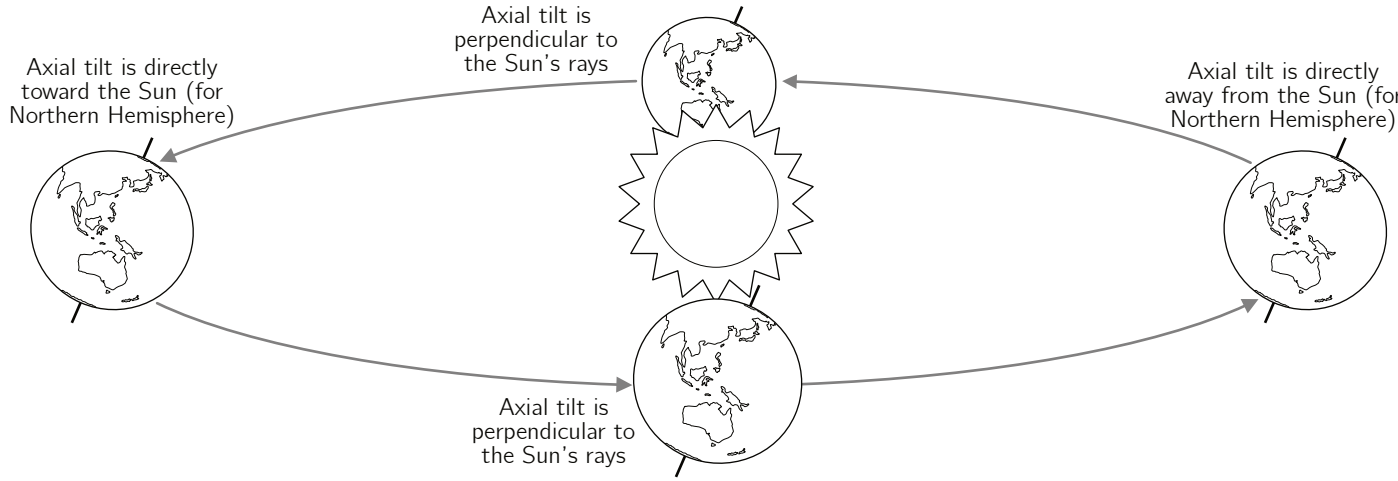
DEFINITION: _____

_____

_____

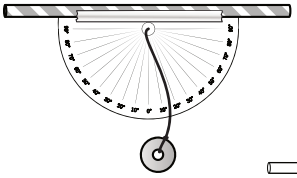
_____

Four points in Earth's orbit are described in the diagram below. Label each with the correct equinox or solstice for the Northern and Southern Hemisphere. Also include the approximate date.
Note that distance and size are not to scale.

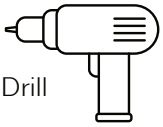


DIY Equatorial Sundial

MATERIALS

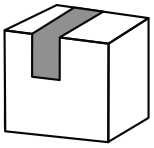


Inclinometer

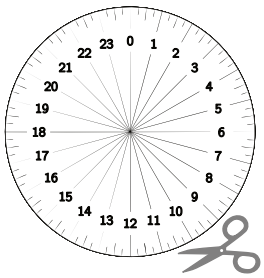


Drill

Wooden dowel



Cardboard or wood



Sundial template and scissors

GOALS

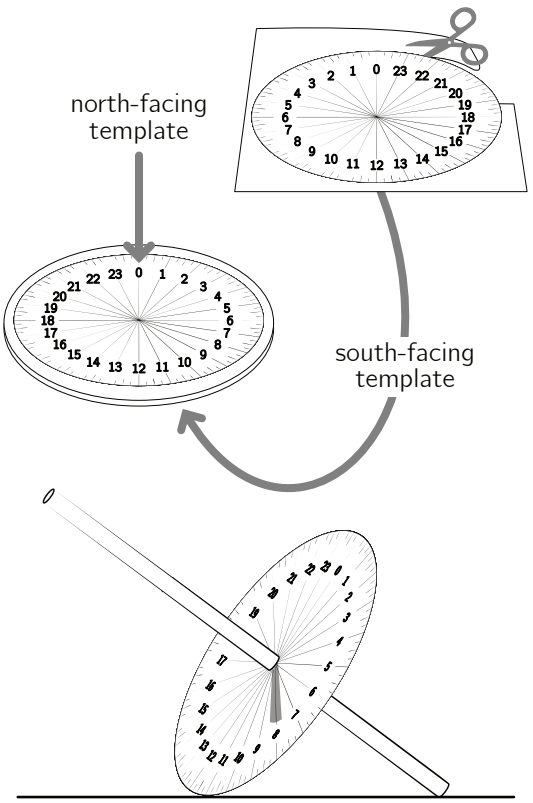
- Learn more about the Sun's path and Earth's orbit by building a working sundial.
- Adjust your sundial to give accurate time by considering various factors.

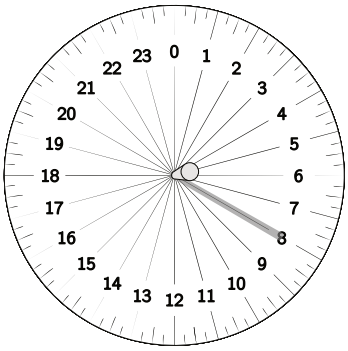
What's an Equatorial Sundial?

An equatorial sundial uses a shadow stick (gnomon) to cast a shadow on a circular dial. The dial is placed so that it's parallel to the Earth's equator. As long as it's properly aligned, it can be used anywhere on Earth!

How to make an equatorial sundial:

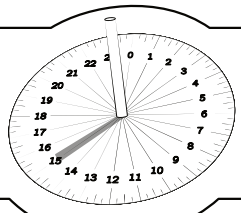
1. Print both the north-facing and south-facing printouts from the appendix and cut them out.
2. Glue or tape them to a solid backing such as cardboard. The backing should be sufficiently thick and rigid so that it can hold a rod perpendicular to the face of the dial without tipping. Be sure that the 0s are aligned.
3. Drill a hold in the center of the dial so that the dowel fits snugly in the hole but can be slid in or out.
4. If you are in the Northern Hemisphere, point the dial so that the gnomon is pointed directly at Polaris. (If you are in the Southern Hemisphere, point the gnomon to Polaris Australis.) Secure the gnomon so it remains pointed toward a pole star. Note that geographic or true north/south is different than magnetic north or south which you would get from a compass.
5. Use your inclinometer to check that the angle of your gnomon matches your latitude.
6. Rotate the dial so that the center of the shadow shows the correct time on the sundial. For example, if it is 8 in the morning, rotate the dial so the shadow is over 8. If it is 2 in the afternoon, rotate your sundial so the shadow is over the 14. Be sure the gnomon remains pointed at geographic north/south as you make adjustments.
7. Observe the shadow on your sundial for one or more days. Does it continue to give the correct time?





Does the dial of a sundial need to be tilted?

It's possible to design a sundial that is flat on the ground, but it must be based on an elliptical shape, and the gnomon must be moved to a different location each day. To learn more about other sundials, look up "horizontal sundials" and "analemmatic sundials."



1. When you placed your sundial outside, did it accurately tell the time? Check on it over several days or weeks to see how it does. What factors might cause discrepancies between the sundial time and standard clock time?

2. Would your sundial work if located at the North Pole or South Pole? Why or why not?

3. Why does a sundial in the Northern Hemisphere need to be aligned with geographic north rather than magnetic north?

4. What was the most interesting thing you learned doing this project? OR What challenge or obstacles did you encounter making your sundial and how did you address them?

LINES OF LATITUDE: significant circles

DECEMBER SOLSTICE

On the December solstice, Earth is tilted so the South Pole is angled toward the Sun. Observers around the South Pole experience "polar day" or the "midnight sun."

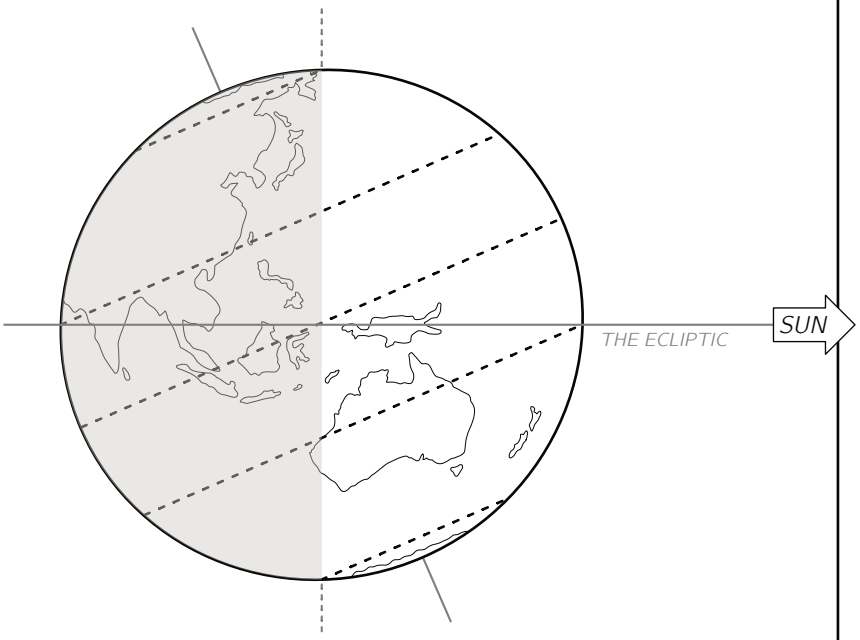
The border of this region where the Sun does not set below the horizon on December solstice is called the **Antarctic Circle**.

On the same day, observers in the region around the North Pole experience "polar night." The line of latitude surrounding this area is called the **Arctic Circle**.

These circles are defined as the latitudes where, during solstice, the center of the Sun remains continuously above or below the horizon for at least 24 hours.

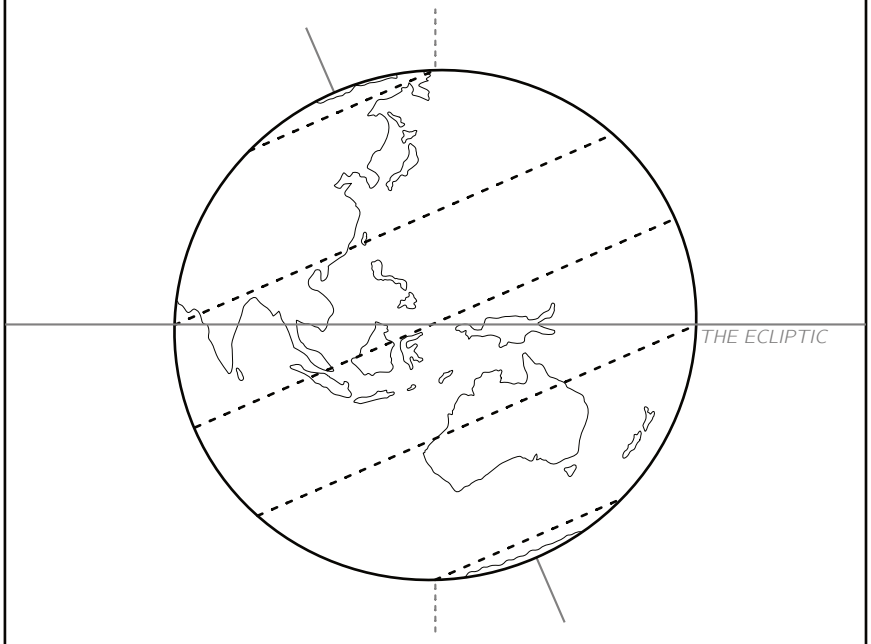
On the December solstice, the latitude of 23.5° South intersects with the ecliptic. At this latitude, the Sun will be directly overhead. This southern most point where the Sun can appear directly overhead at noon is called the **Tropic of Capricorn** or "Southern Tropic." The word tropic comes from the Greek word *tropos*, meaning to turn.

Label the dotted lines of latitude



JUNE SOLSTICE

Draw an arrow to indicate the direction of the Sun and shade the hemisphere that would experience night. Label the dotted lines of latitude.



On the June solstice, what area of Earth will experience polar day?

_____

On the June solstice, what area of Earth will experience polar night?

_____

At the equator, will the Sun be directly overhead during either solstice? Why or why not?

_____

_____

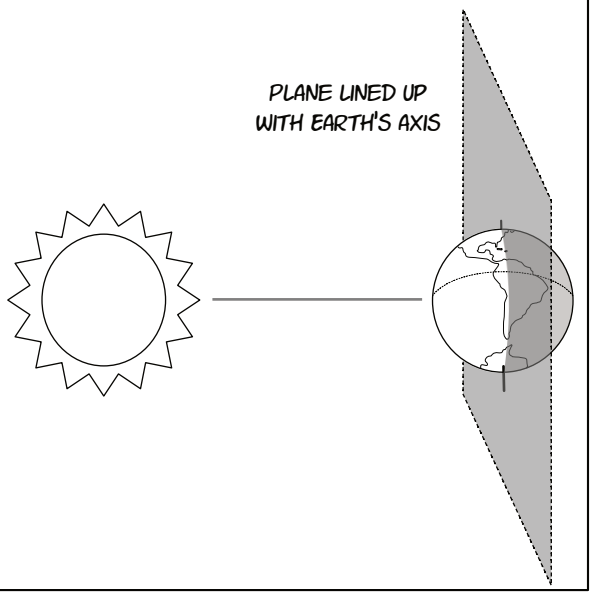
_____

Fill in the blanks:

equal *equinox* *location* *overhead* *perpendicular* *terminator*

During each _____, the tilt of the Earth is _____ to the line between the Sun and Earth. Equinoxes are the only time of year when the Sun appears to be directly _____ at the equator.

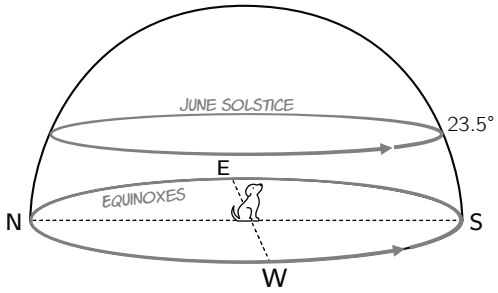
When the solar _____ or "edge" between night and day is perpendicular to the equator, it causes a cool effect: Each equinox, almost every _____ on Earth experiences _____ hours of light and darkness.

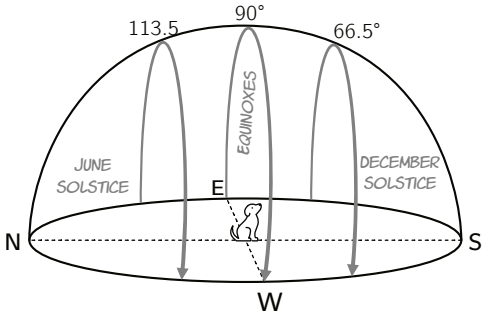


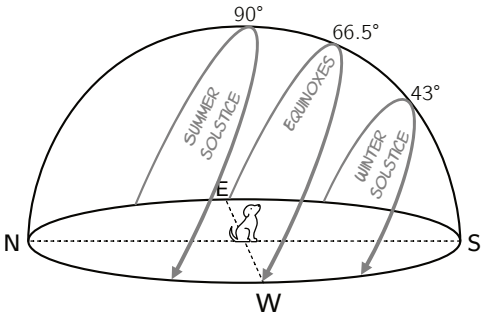
SOLSTICE vs EQUINOX Views from the ground

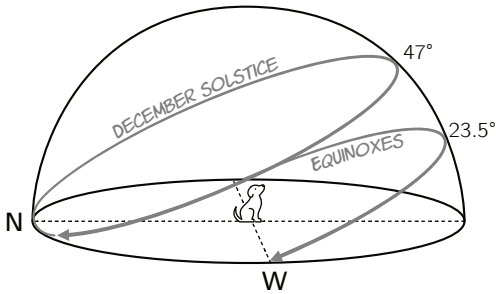
The hemispheres below show the view of the Sun's path in the sky at solstices and equinoxes. Label each with the correct location for the observer.

Locations could be: Arctic Circle, Antarctic Circle, equator, North Pole, South Pole, Tropic of Cancer, or Tropic of Capricorn.









THE MOON: Earth's closest friend

Make a Model

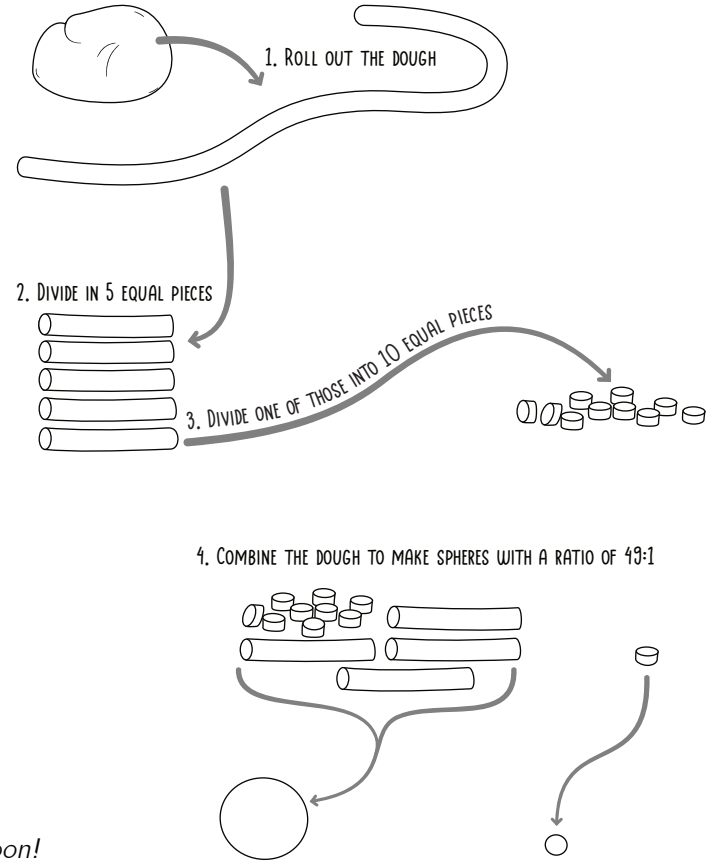
Earth and its moon are usually illustrated with their distance and size NOT to scale.

Here's a great modeling exercise to help you see how Earth and the Moon compare in size and how far apart they are from each other.

The only supplies you need are some clay or dough. A ruler or a piece of string might also be handy for estimating distance.

1. Roll the dough into a cylinder and divide it into five equally-sized portions.
2. Then divide one of those pieces into 10 equal size pieces.
3. Remove one of the small portions and roll it into a sphere. This sphere represents the Moon.
4. Combine the rest of the dough and roll it into a sphere. This sphere represents the Earth.
5. Measure the diameter of the model Earth. You can use a ruler or string or just take a visual estimate. Then place the Moon 30 "Earth diameter-lengths" away from your model Earth.

You now have a scaled model of the Earth and Moon!



Moons are natural satellites that orbit planets. Earth's moon, known simply as the Moon, is unusually large compared to the size of the Earth.

As it orbits Earth, different portions of its illuminated surface are visible from Earth; these are called the **phases of the Moon**. People have used them to measure the passage of time and other animals change or coordinate their activity based on the lunar cycle.

Draw a line to match each description with the correct term:

The illuminated portion of the Moon is getting bigger	The visible Moon is fully illuminated by sunlight	The near side of the Moon is becoming more shadowed	No sunlight is shining on the near side of the Moon	Half of the visible Moon is illuminated
				

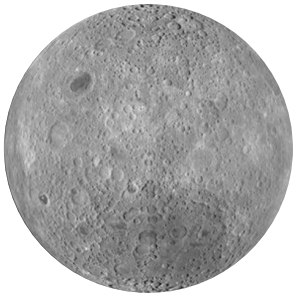
WAXING | FULL MOON | WANING | FIRST QUARTER OR LAST QUARTER | NEW MOON

The Near & Far Sides of the Moon

The Moon is **tidally locked** with Earth, meaning that the same side is always facing Earth. The side of the Moon that we see from Earth has abundant craters, but there are also darker patches called **mare** (singular) or **maria** (plural). Formed by flood basalt, maria are lower in elevation than the lightly-colored lunar highlands.

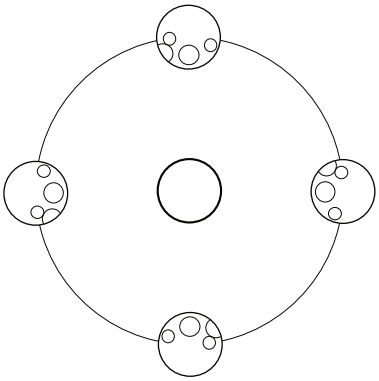
What differences do you observe between the near side of the Moon (the side that faces Earth) and far side of the Moon? Does the Moon rotate? Why or why not?

NEAR SIDE

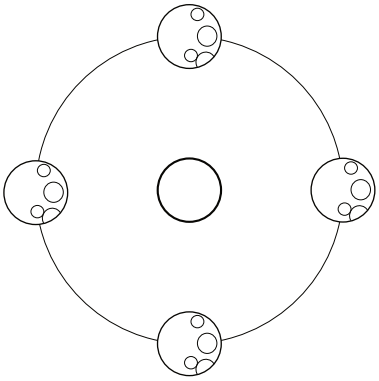


FAR SIDE

Image credits: NASA's Lunar Reconnaissance Orbiter/GSFC/Arizona State University



Tidally locked moon: the same side always faces the planet.



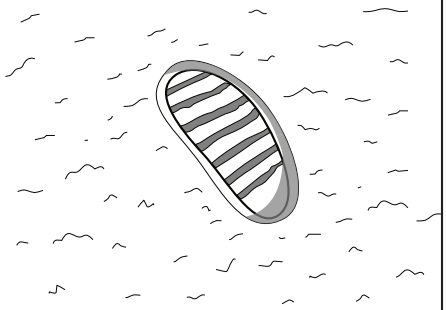
NOT tidally locked: the planet sees different sides of the moon.

Fact or Fiction?

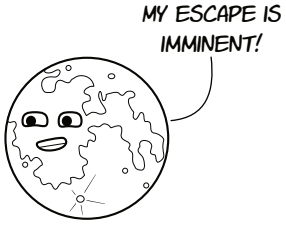
Consider each statement, then write whether it is fact or fiction.

The Moon is a dwarf planet that came too close and was captured by Earth's gravity

Only 12 people have stepped on the Moon's surface. Their footprints are still visible today.

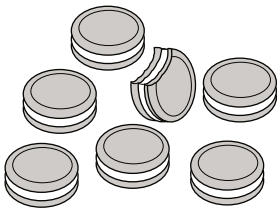


The Moon is drifting away from Earth at a rate of about 4 meters per year



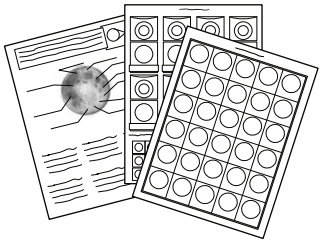
Cookie Models and Journal

MATERIALS

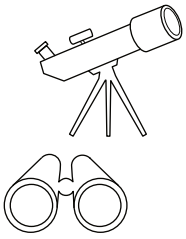


Sandwich style cookies with cream filling and a butter knife (optional)

Pencil, pen, or coloring supplies



Observe the Moon Page, Cookie Moon Phases Page, & Moon Journal Page,



Binoculars or telescope (optional)

GOALS

- Become more familiar with the Moon and its phases.
- Practice observing natural phenomena and keeping a detailed record of observations.

Complete the following 3 activities:

1. Observe the Moon & Label Famous Craters and Maria

You can observe the Moon during any of it's phases, but craters will be more visible when the Moon is NOT in the full moon phase. The more pronounced shadows of a crescent or quarter moon make it easier to see craters. Observe the Moon without any tools or equipment (naked eye), with binoculars, or with a telescope.

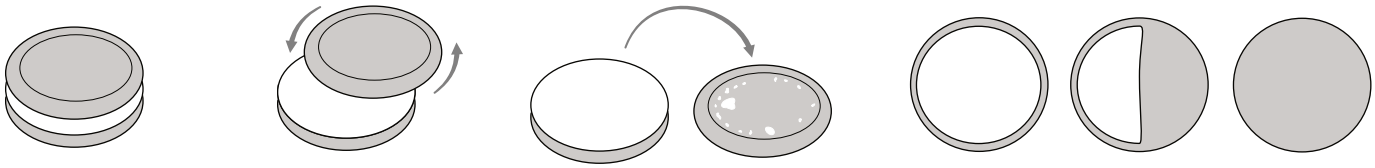
If you are unable to observe the Moon directly, you can explore virtually at https://science.nasa.gov/moon/

Use the descriptions of the craters and maria and online resources such as NASA to label the features on the **Observe the Moon** page. Then check the boxes next to each feature you're able to observe on the actual Moon.

Note: you may need to observe the Moon multiple times at different phases to be able to observe all 10 features.

2. Moon Phase Models

Fill out the chart on the **Cookie Moon Phases** page and check to be sure it's completed correctly. Then get 4 sandwich-style cookies. Carefully twist off the tops of each cookie. Use a butter knife to adjust the cream filling so that the cookie halves match the 8 phases of the moon. Once the cookies are complete, pick one at random. Can you place the remaining 7 phases in order? Complete this 3 times, with 3 different cookies as starting points. Bonus points if you can arrange the cookies in the correct order and name the phases without using the chart as a guide.



3. Observe moon for 30 days and draw/record phases

Observe the Moon daily for one month. Using the **Moon Journal Page**, record the date and the Moon's appearance by shading the portion that is shadowed or dark. If you are unable to observe the Moon due to clouds or other factors, write "no" (no observation) or "no data" in the circle.

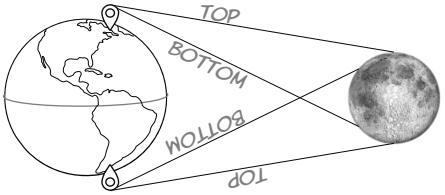
Did you observe the same phases during the 30 day time period?

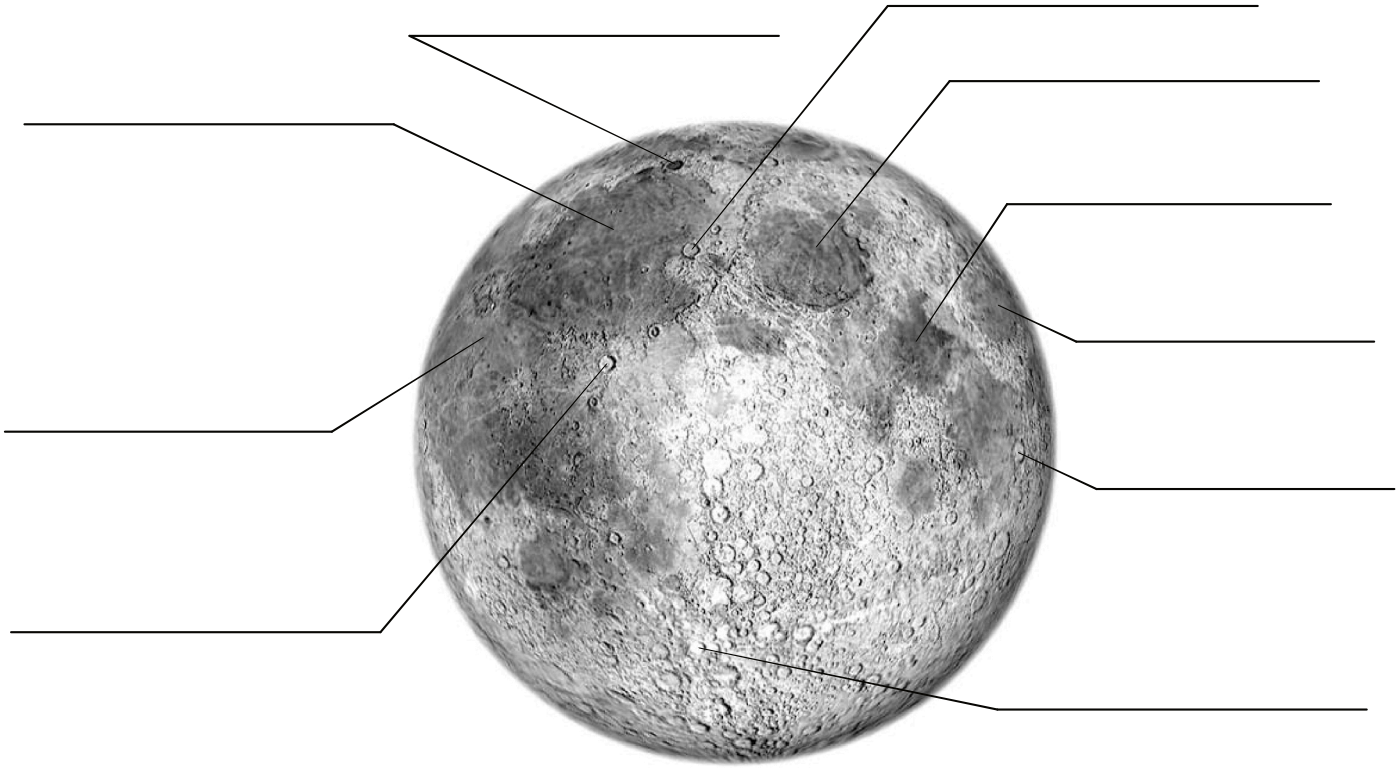
Did you observe any differences in when and where you could see the Moon during this month?

Observe the Moon (and Label Famous Craters and Maria too!)

The Moon's orientation depends on where we observe it!

*When viewed from the **Northern Hemisphere**, the Moon most often looks like the image below where the large maria are on "top" relative to the horizon. When viewed from the **Southern Hemisphere**, the orientation is reversed.*





CRATERS Place a checkmark by each crater you are able to observe on the Moon:

☐ Archimedes - In September of 1959 the Soviet probe Luna 2 crashed near this crater. It was the first craft to reach the Moon.
Diameter: 82 km

☐ Copernicus - This crater has rays that extend for more than 850 km and overlap other craters. It also has several peaks in the center
Diameter: 93 km

☐ Langrenus - This crater is on the eastern side of Mare Fecunditatis (south of Mare Crisium). It's central peak is about 3 km tall.
Diameter: 130 km

☐ Plato - This lava-filled impact crater has a floor that is darker than the surrounding terrain and lacks a central peak.
Diameter: 101 km

☐ Tycho - This distinctive bright white crater is surrounded by rays that extend outward in all directions. Some are over 1,500 km long!
Diameter: 85 km

MARIA Place a checkmark by each maria you are able to observe on the Moon:

☐ Mare Crisium - This is one of the smaller lunar maria, being about the same size as as the country of Uruguay.
Diameter: 556 km

☐ Mare Imbrium - This mare formed when lava flooded a giant crater. It's surrounded by mountains, more than 5 km tall.
Diameter: 1,145 km

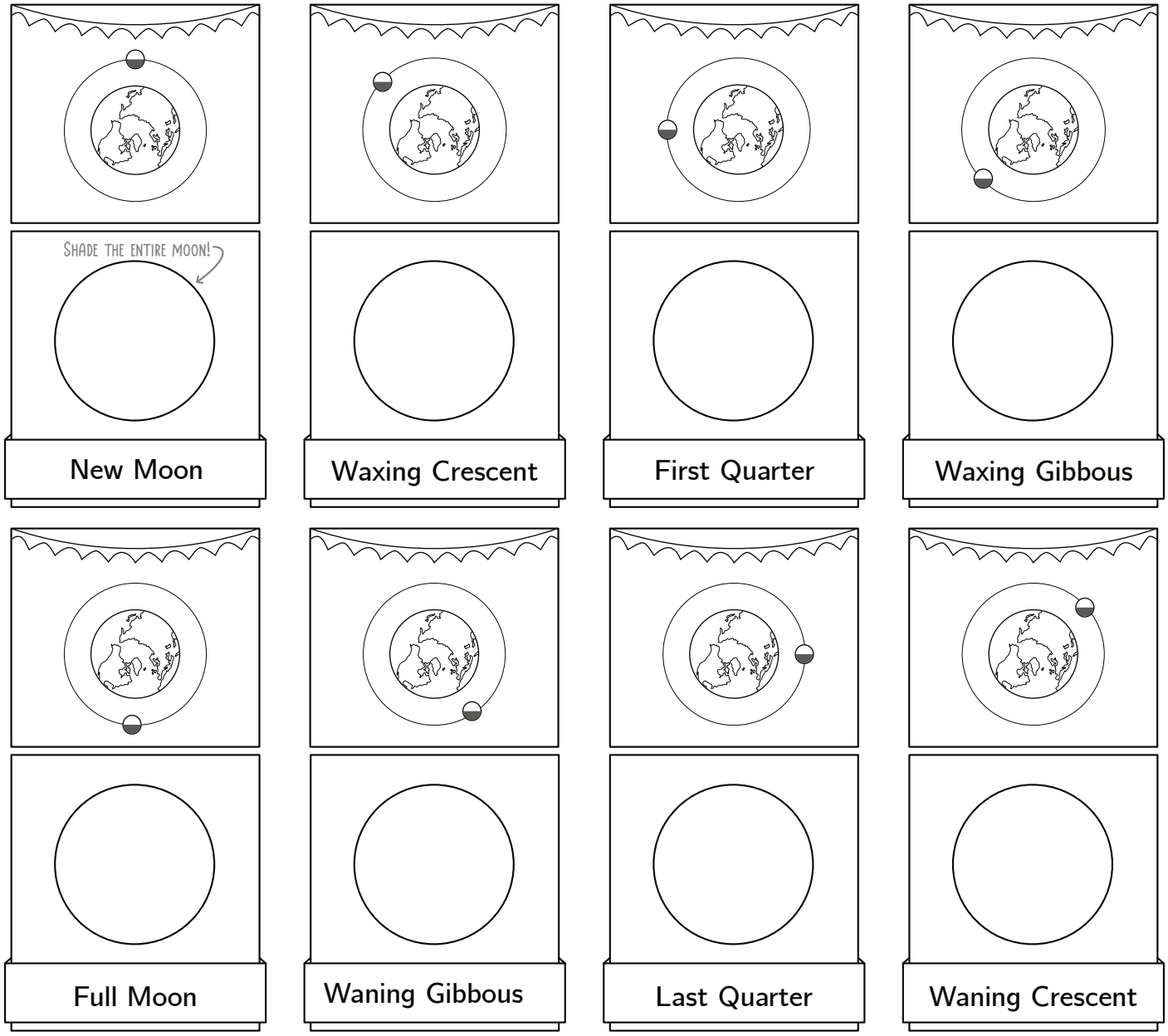
☐ Mare Serenitatis - This mare has a distinct circular shape. It has been visited by multiple lunar landers, including Luna 21 and Apollo 17.
Diameter: 674 km

☐ Mare Tranquillitatis - The Apollo 11 spacecraft landed on the southwest shore of this mare in 1969. The site of the first Moon walk!
Diameter: 876 km

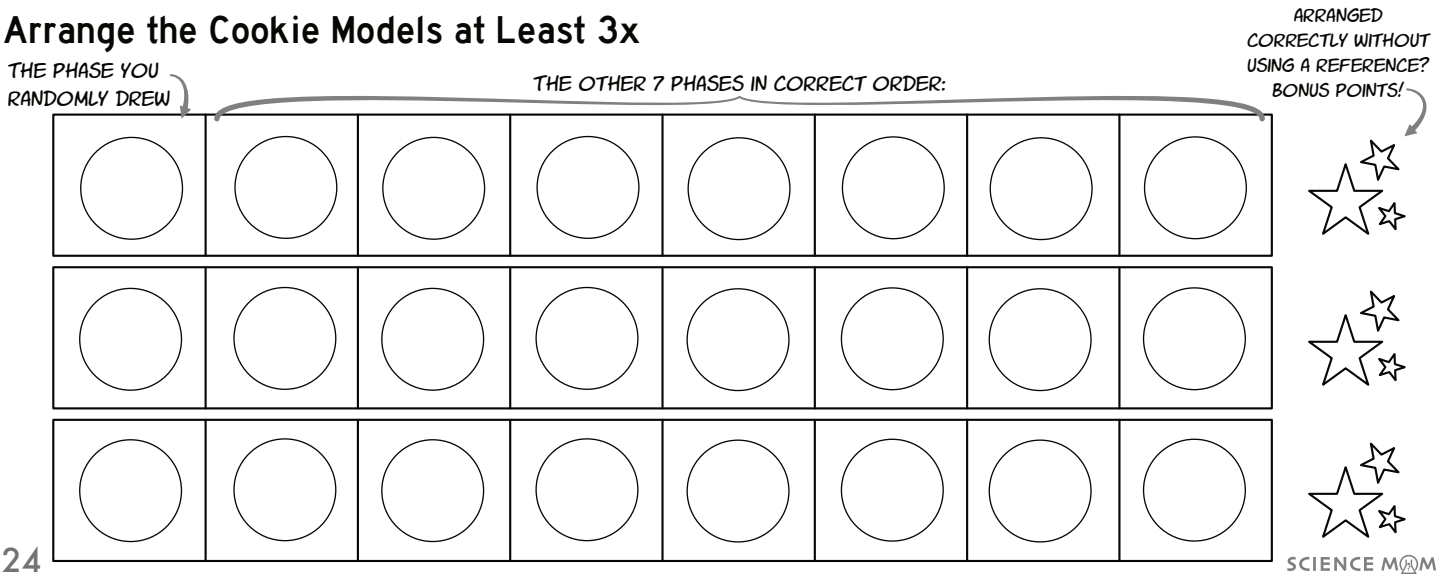
☐ Oceanus Procellarum - This mare is called "oceanus" due to its large size. It is not associated with a crater or impact event.
Diameter: 2,000 - 3,000 km

Cookie Moon Phases

For each phase below, color in the part of the Moon that is in shadow. Note: whether the bright portion of the waxing crescent is on the right or left hand side depends on whether you're in the Northern or Southern Hemisphere.



Arrange the Cookie Models at Least 3x



Moon Journal

Date:	Date:	Date:	Date:	Date:
Date:	Date:	Date:	Date:	Date:
Date:	Date:	Date:	Date:	Date:
Date:	Date:	Date:	Date:	Date:
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