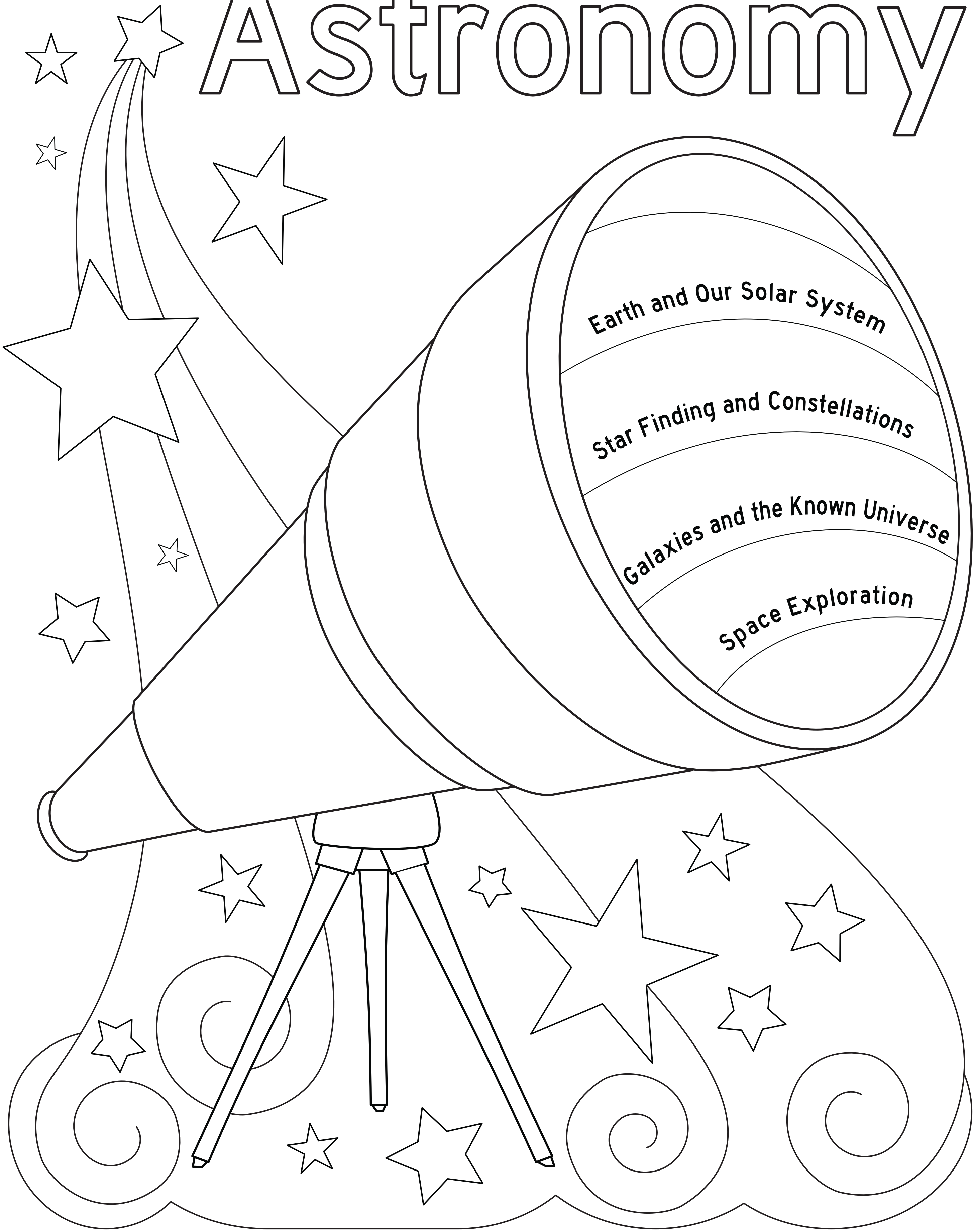
Astronomy


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

ASTRONOMY

Unit	Lesson	Date	Topic	Pages
Unit 1. Earth and the Moon	1	Mon, Jan 13	What Is Astronomy?	4-7
	2	Wed, Jan 15	Diurnal Motion	8-9
	3	Self paced lesson	Measure Your Latitude	10-13
		Mon, Jan 20	No Class (MLK day holiday)	
	4	Wed, Jan 22	The Seasons	14-15
	5	Self paced lesson	DIY Equatorial Sundial	16-17
	6	Mon, Jan 27	Lines of Latitude	18-19
	7	Wed, Jan 29	Our Moon	20-21
	8	Self paced lesson	Cookie Models and Journal	22-25
	9	Mon, Feb 3	Eclipsed	26-27
	10	Wed, Feb 5	Totality	28-29
	11	Self paced lesson	Earth and Moon Review/Assessment	30-33
	12	Mon Feb 10	EARTH & MOON QUIZ SHOW	
Unit 2. Our Solar System	13	Wed Feb 12	Our Solar System	34-35
	14	Self paced lesson	Step Scale Model of the Solar System	36-37
	15	Mon Feb 17	Inner vs Outer Planets	38-39
	16	Wed Feb 19	Planetary Motion	40-41
	17	Self paced lesson	Ellipses & Orbits	42-43
	18	Mon Feb 24	Dwarf Planets and Moons	44-45
	19	Wed Feb 26	Asteroids, Comets and Meteors	46-47
	20	Self paced lesson	Flour and Cocoa Craters	48-49
	21	Mar 3	Near Earth Objects	50-51
	22	Mar 5	SOLAR SYSTEM QUIZ SHOW	
	23	Self paced lesson	Solar System Review/Assessment	52-55
Spring Break is March 10-15				
Unit 3: Stars, Galaxies, and the Universe	24	Mar 17	The Sun as a Star	56-57
	25	Mar 19	Solar Weather	58-59
	26	Self paced lesson	**Star Classification Poster**	60-64
	27	Mar 24	The Scale of Space and Galaxies	65-66
	28	Mar 26	Main Sequence Stars	67-68
	29	Self paced lesson	Make a Constellation Viewer	69-70
	30	Mar 31	Supernovas and Black Holes	71-72
	31	Apr 2	Stargazing 101	73-74
	32	Self paced lesson	**Stargazing Scavenger Hunt**	75-78
	33	Mon, Apr 7	Constellations	79-80
	34	Wed, Apr 9	The Known Universe	81-82
	35	Self paced lesson	Stars & Universe Review/Assessment	83-88
	36	Mon, Apr 14	STARS & UNIVERSE QUIZ SHOW	

Unit	Lesson	Date	Topic	Pages
Unit 4: Space Exploration & Mysteries	37	Wed, Apr 16	The Tools of Astronomy	-
	38	*Self paced lesson*	**Candy Bar Heat Shield**	-
	39	Mon, Apr 21	Space Exploration 1: Lunar Missions	-
	40	Wed, Apr 23	Space Exploration 2: Beyond the Solar System	-
	41	*Self paced lesson*	**Make a Cardboard Rover**	-
	42	Mon, Apr 28	Space mysteries 1: Dark Matter & Dark Energy	-
	43	Wed, Apr 30	space mysteries 2: Quasars & More	-
	44	*Self paced lesson*	Review for Quiz Show	-
	45	Mon May 5	FINAL QUIZ SHOW	-

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
- 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 27 - 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 30 - Make a Constellation Viewer
- Cylindrical cardboard container
- Constellation printout
- Nail or pin
- Phone (with a flashlight)

Lesson 32 - Stargazing Scavanger Hunt
- Stargazing scavenger hunt printout
- A pair of binoculars or telescope (optional)
- Stargazing app such as Sky Guide, Star Walk, Night Sky, Sky Safari, or Stellarium

Lesson 39 - Candy Bar 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

Lesson 42 - Make a Cardboard Rover
- Corrugated cardboard (enough to make several squares roughly 15 cm (6 in) across)
- 1 sharpened cylindrical pencil
- 2 pieces of hard candy with a hole in the middle
- Straw
- Rubber bands
- Ruler
- Tape OR a hot glue gun
- Scissors

Unit 1: Earth & the Moon

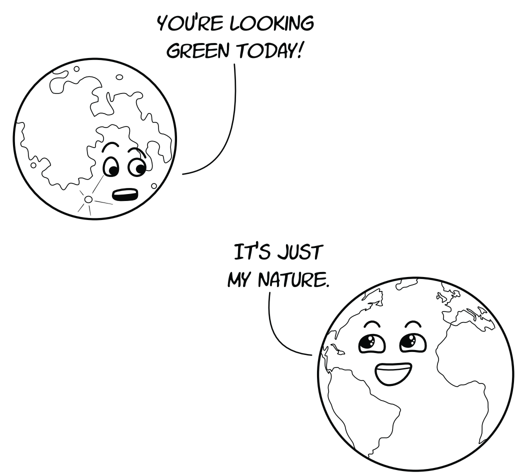
Words are more than tools for communication, they are the framework of knowledge! Without language to express and define new ideas, we wouldn't be able to learn.

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.

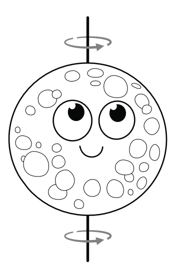
If there are terms or words you don't know, don't worry! We'll be learning them in future lessons. As you learn new concepts, come back to these pages and label each card.

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.

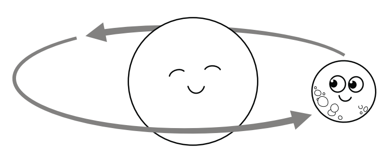


APHELION DIURNAL MOTION ECLIPSE ECLIPTIC EQUATOR
HEMISPHERE HORIZON LATITUDE LONGITUDE ORBIT
PERIHELION PRIME MERIDIAN REVOLVE ROTATE ZENITH

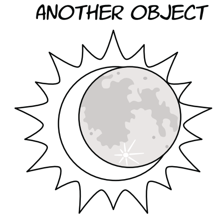
TO SPIN AROUND AN AXIS OR CENTER



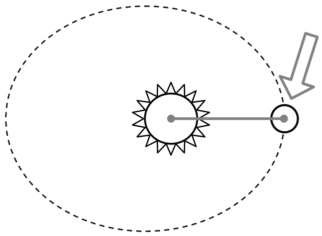
TO MOVE IN A CIRCULAR PATH AROUND AN OBJECT; TO ORBIT AROUND SOMETHING



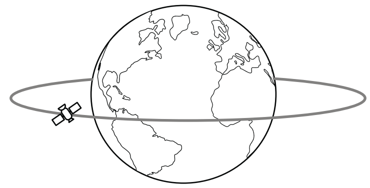
WHEN ONE OBJECT PASSES IN FRONT OF ANOTHER; WHEN ONE OBJECT PARTIALLY OR TOTALLY BLOCKS THE VIEW OF ANOTHER OBJECT



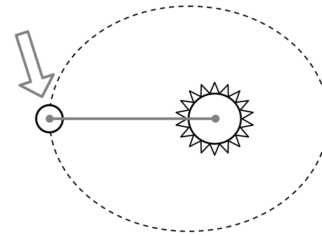
THE POINT WHERE AN ORBITING OBJECT IS CLOSEST TO THE SUN



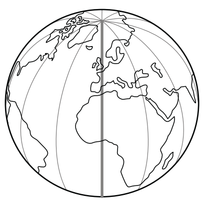
THE CURVED PATH AN OBJECT TAKES AROUND A STAR, PLANET, OR MOON



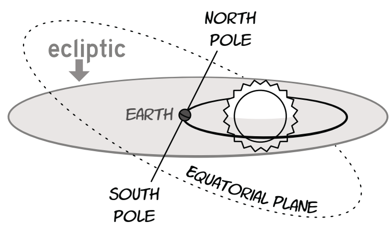
THE POINT WHERE AN ORBITING OBJECT IS FURTHEST FROM THE SUN



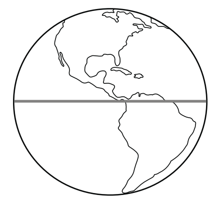
A LINE FROM NORTH TO SOUTH POLE THAT PASSES THROUGH GREENWICH, ENGLAND



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

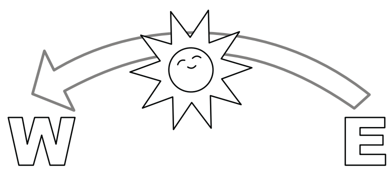


A LINE AROUND THE EARTH THAT IS EQUALLY DISTANT FROM THE NORTH / SOUTH POLES.

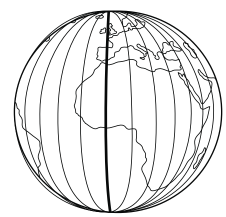


PARALLEL LINES THAT MEASURE DISTANCE FROM THE EQUATOR

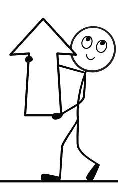
THE REPEATED DAILY MOVEMENT OF STARS AND OTHER OBJECTS ACROSS EARTH'S SKY FROM EAST TO WEST



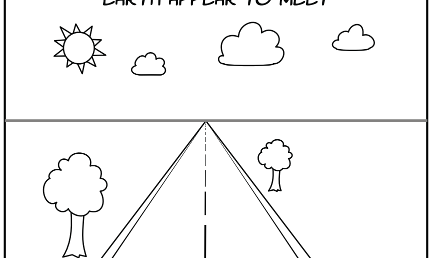
LINES THAT MEASURE DISTANCE FROM THE PRIME MERIDIAN



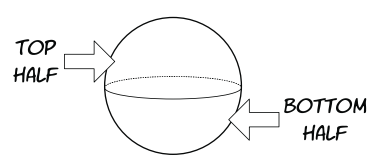
THE POINT IN THE SKY THAT IS DIRECTLY ABOVE THE OBSERVER



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!

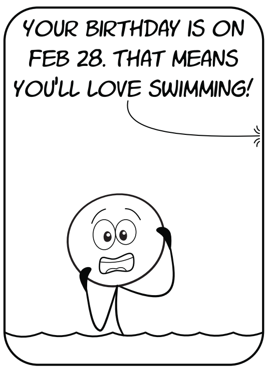
Astronomy is: ____

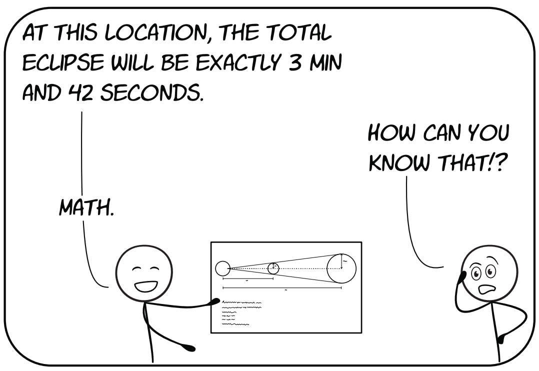
____

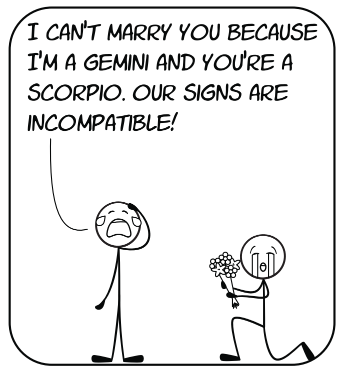
Astrology is: ____

____

IS IT ASTRONOMY OR ASTROLOGY? Label each scenario below:



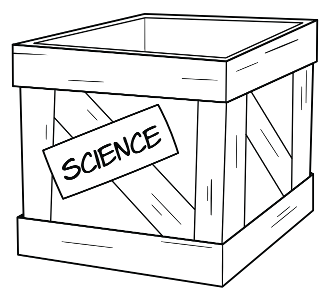


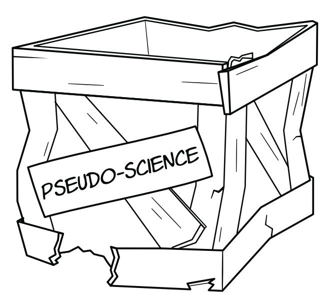


IS IT SCIENCE OR PSEUDOSCIENCE?

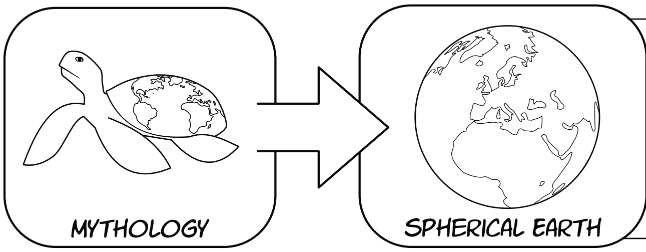
Match each characteristic with the appropriate box

- 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





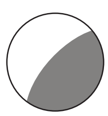
Concepts of Earth through Human History



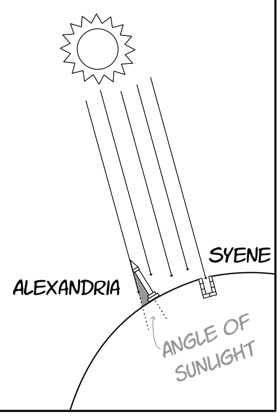
In ancient times, many cultures had mythology depicting the Earth as being flat or being part of a giant tree or on the back of a large animal.

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

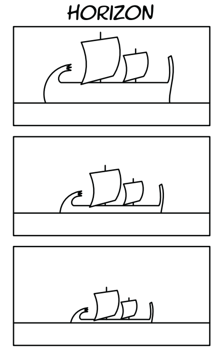


Eratosthenes
approximately 250 BCE

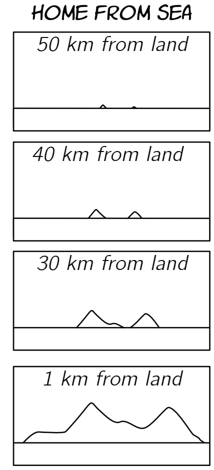


Ptolemy
approximately 150 CE

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



LAND APPEARS "TOP FIRST" WHEN COMING HOME FROM SEA

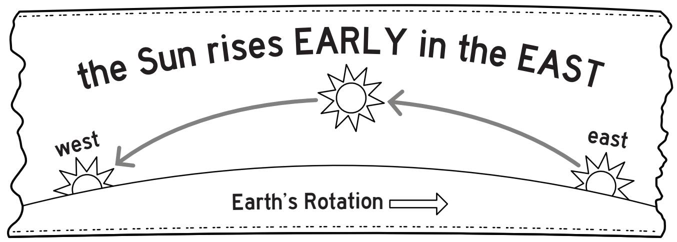


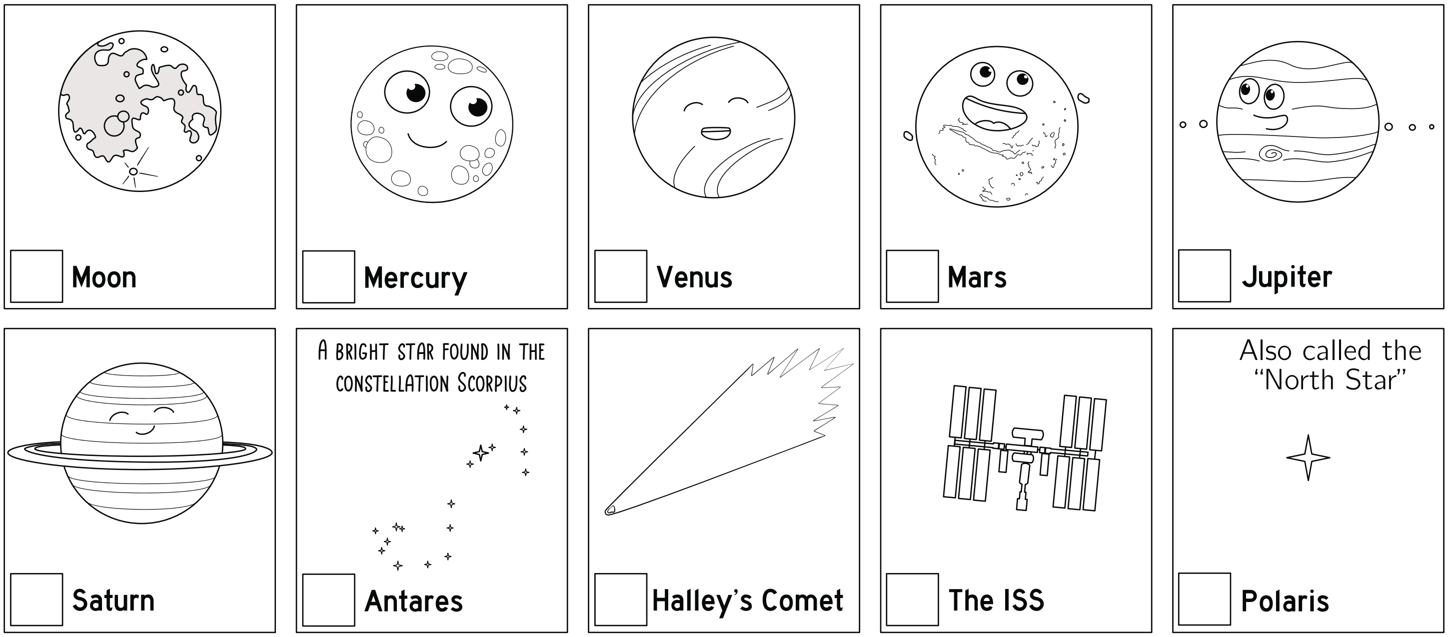
Our Current View of Earth:

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:

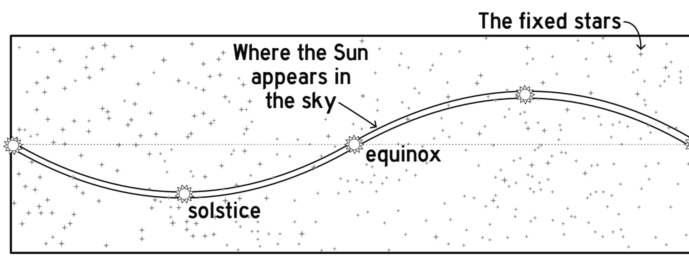


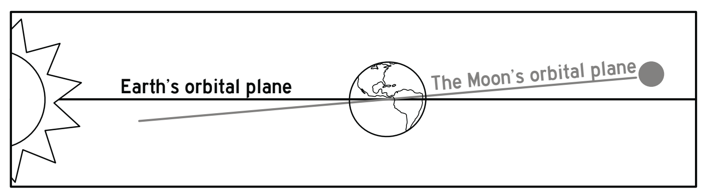


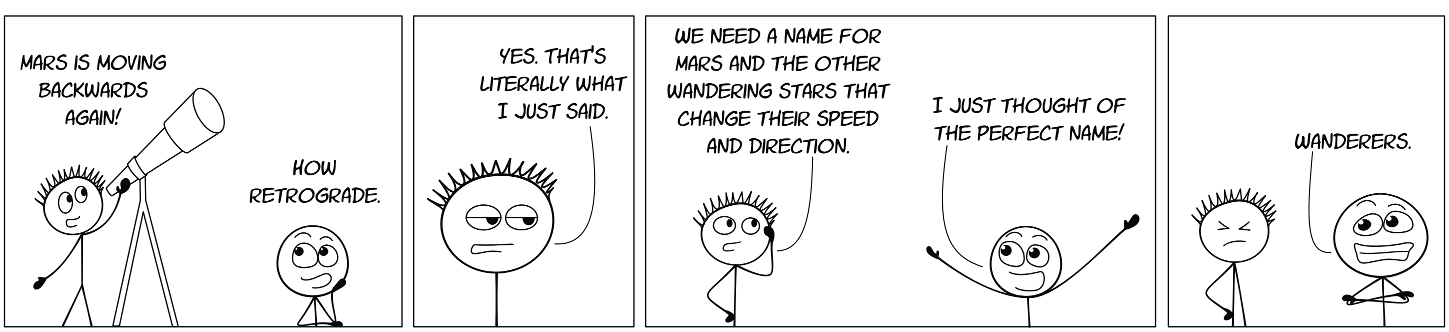
Over the course of a year, the Sun appears to travel through the fixed stars, tracing a path called the **ecliptic**.

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.



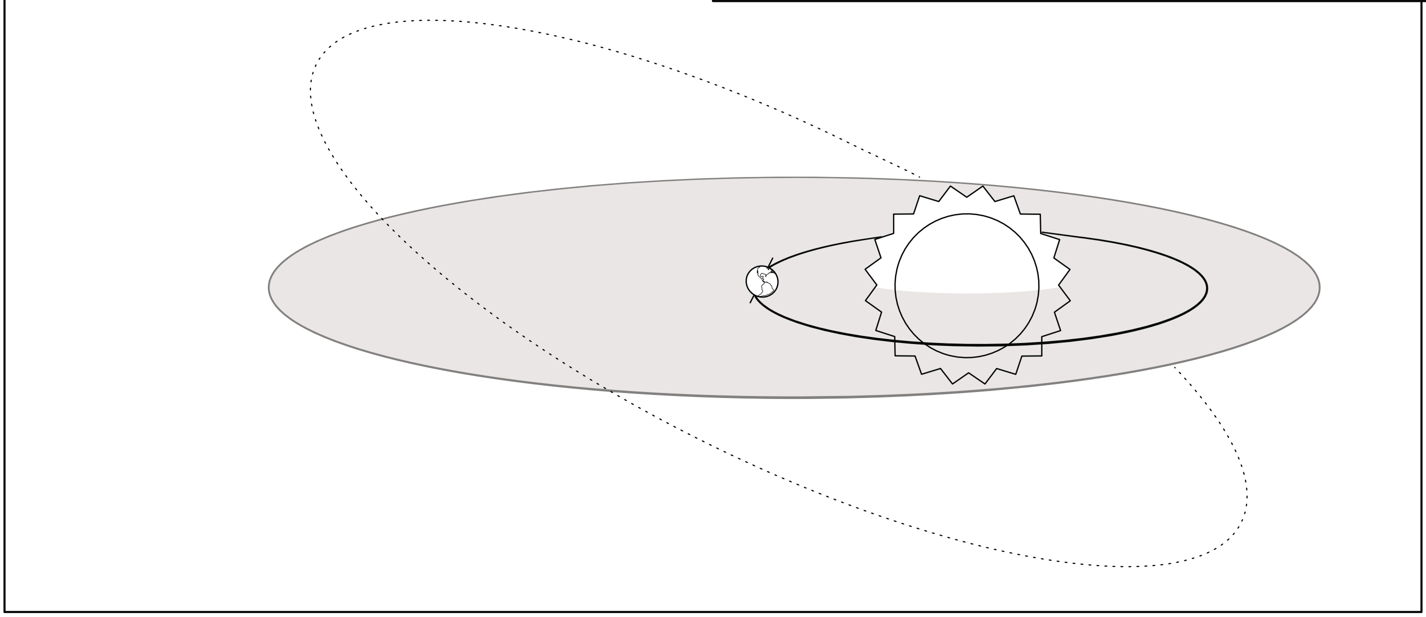




The English word "planet" comes from the Greek word planētēs which means "wanderer."

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!

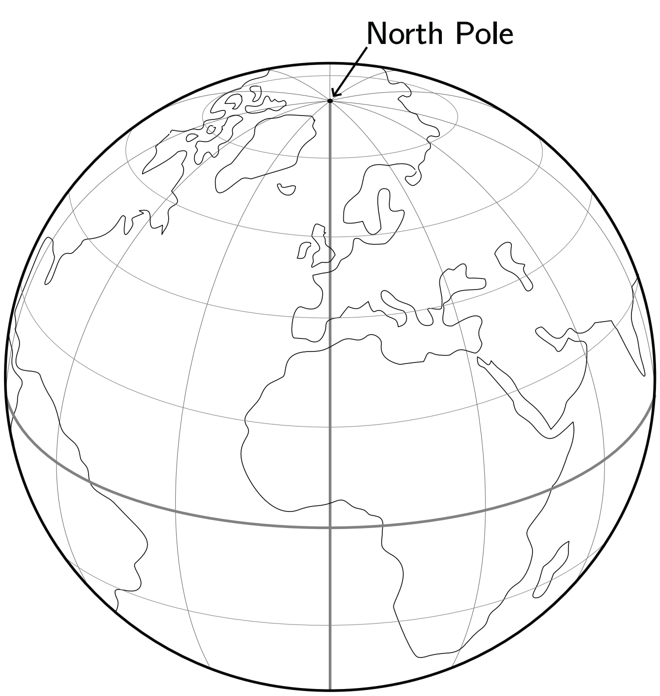
Define these terms and describe how long it takes the Earth to complete one of each:

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.

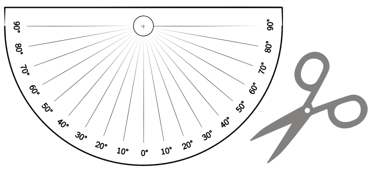
____

Lines that measure distance from the prime meridian.

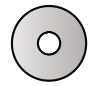
Measure Your Latitude

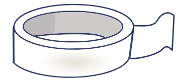
MATERIALS

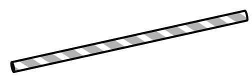

~15 cm of thread or string

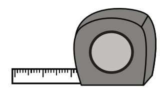

Protractor template and scissors OR a standard protractor


Pin


Washer or other weight


Tape


1 straw


Tape measurer

GOALS

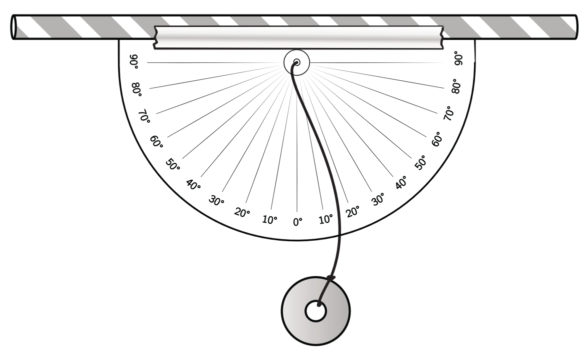
- Build a device to measure the angle of incline of a distant object.
- Find the latitude of your current location.

Purpose of an inclinometer

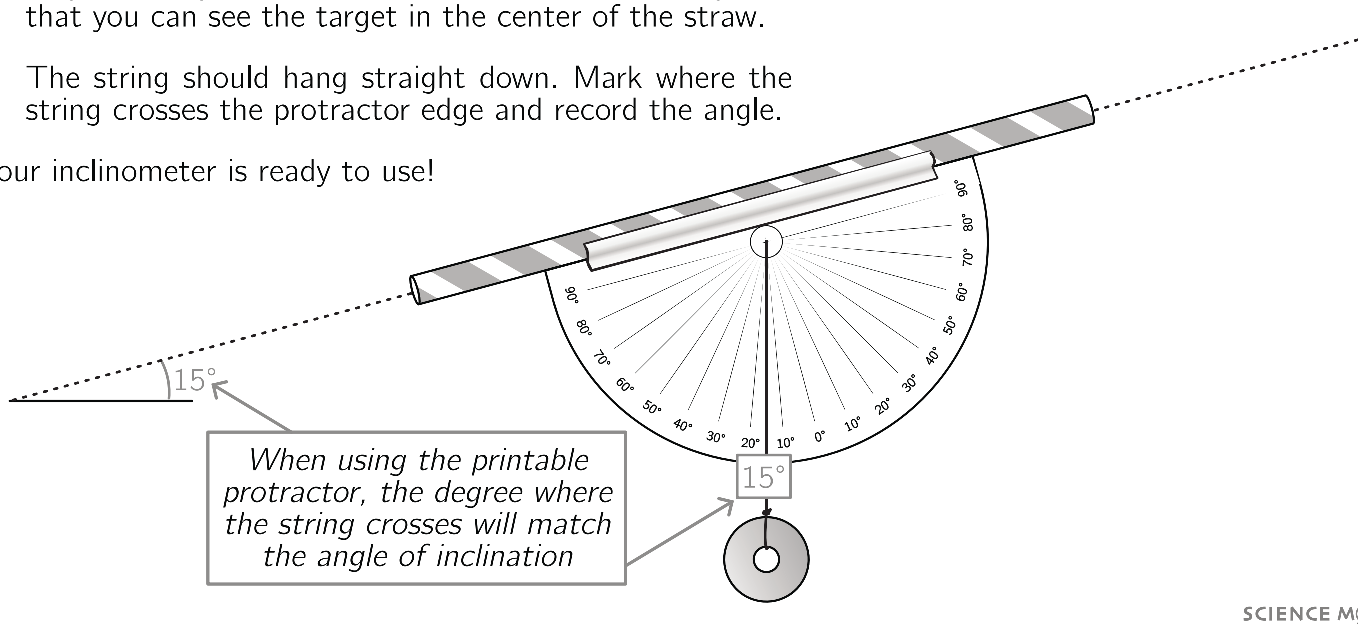
An inclinometer (sometimes called clinometer) is a tool that helps you to measure the angle or inclination of an object. With a little bit of geometry, inclinometers can be used to find the height of an object or the latitude of a person's current location.

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!



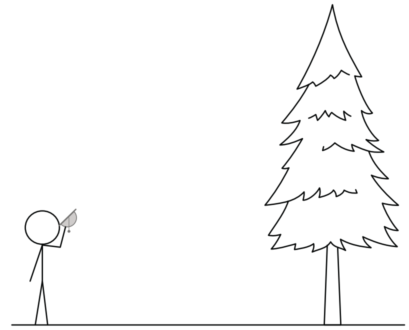
How tall is it?

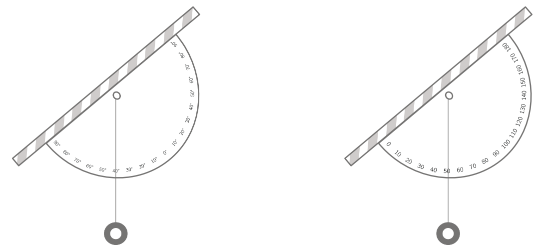
Before finding our latitude, it's important to understand how an inclinometer works by using it to find the height of an object.

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

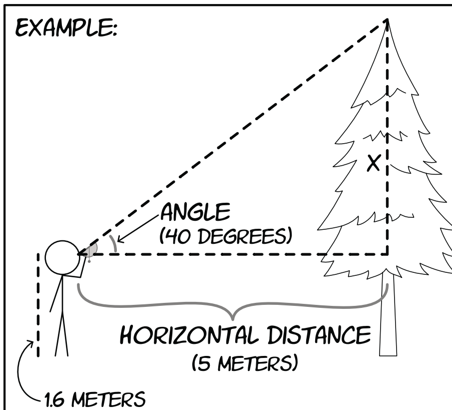
8. Add the height of the observer to x to find the total height of the object.





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: ______________________

x = tangent(angle of inclination)·horizontal distance

Estimated height before measuring: ____________

Horizontal distance (observer to object): __________

Eye level height of observer: ____________

x + eye level height of observer = object height

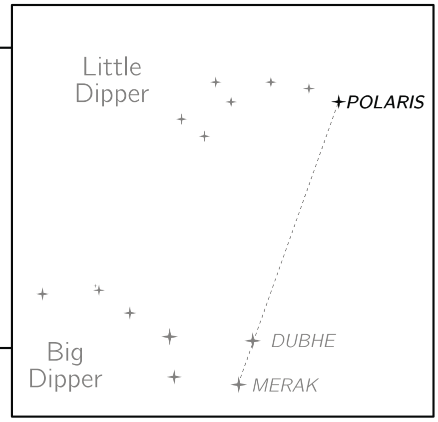
Angle of inclination: ______________

Calculated height of the object:

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

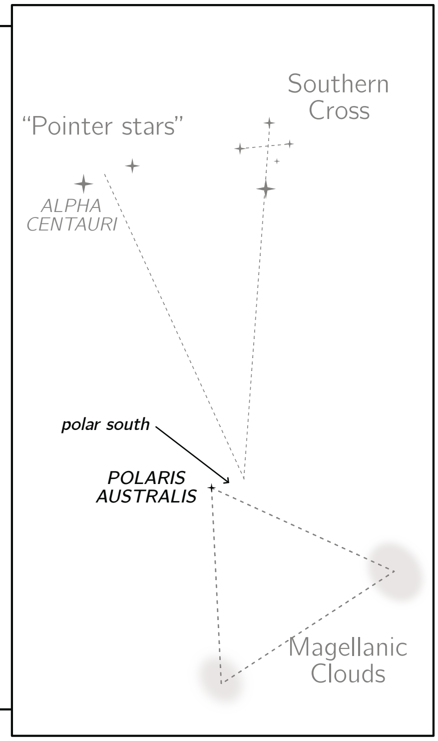
Use the inclinometer to find your latitude by locating Sigma Octantis (also called Polaris Australis or the Southern Star). It is not located exactly over polar south, but it's close! You can use an app such as Sky Guide or find it by using one of these approaches:

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.

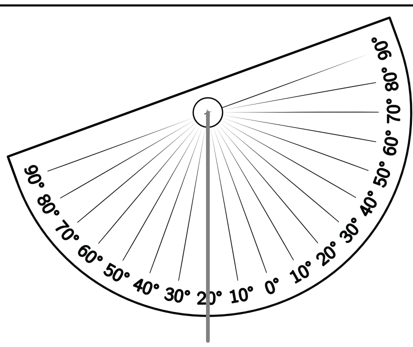
To find your latitude with the inclinometer, look at Polaris Australis, through your straw. Hold the inclinometer steady with the string hanging freely down. Note where the string crosses the edge of the protractor.



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

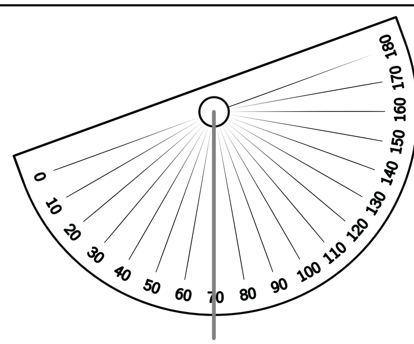
If using a **standard protractor**, take the angle where the string crosses the edge and then subtract it from 90°. Now you have found the ***angle of inclination***.

EXAMPLE WITH PRINTABLE PROTRACTOR:



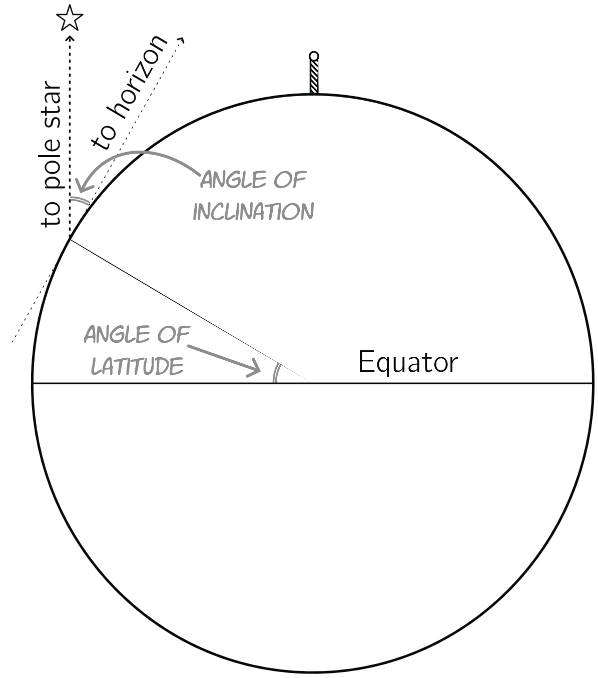
The string crosses at 20°, so the angle of inclination to the pole star and latitude are also 20°. If in the Northern Hemisphere, the latitude would be 20° North. In the Southern Hemisphere, the latitude would be 20° South.

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.

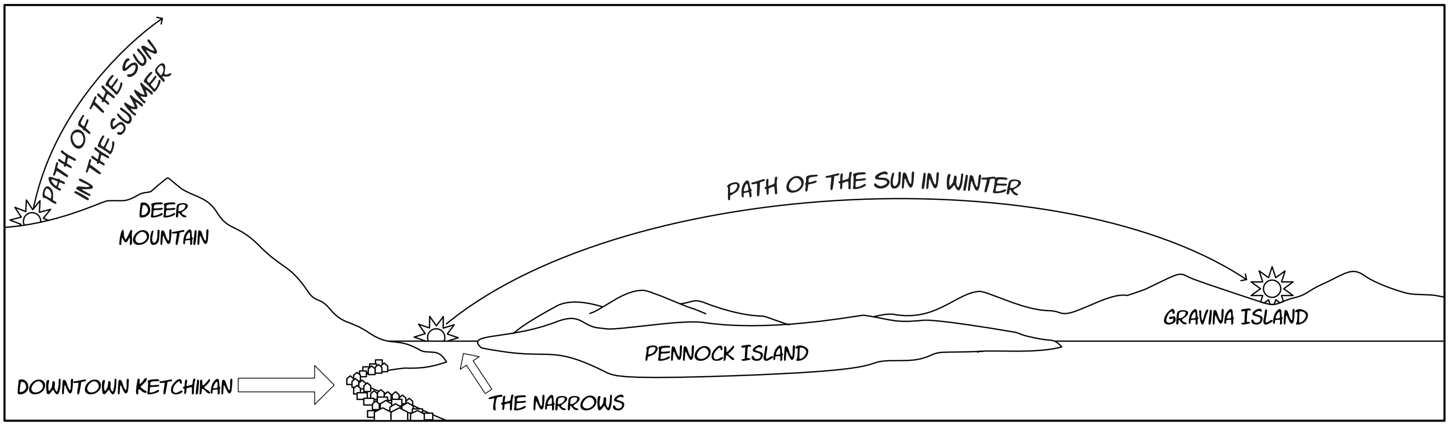


2. At your location, what angle of inclination did you observe when sighting the pole star (Polaris or Polaris Australis)?

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: ____

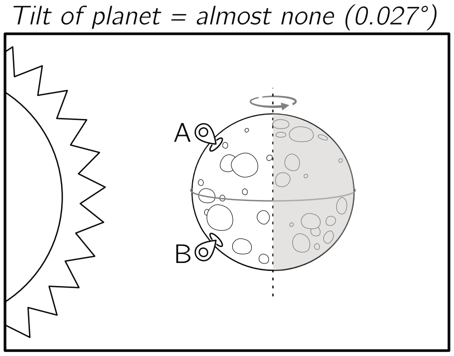
____

During summer:____

____

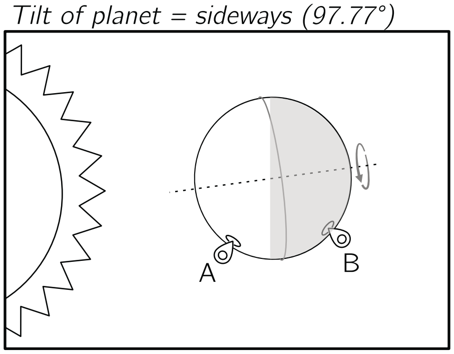
How much sunlight in 1 day?

Tilt of planet = almost none (0.027°)



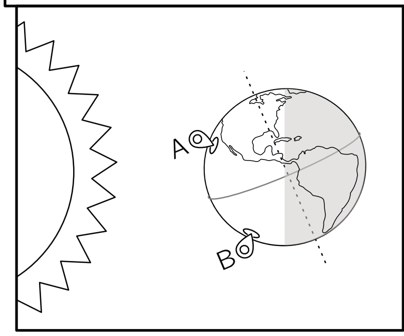
A planet with almost no tilt undergoes 1 complete rotation in 24 hours. During that time, will point A receive more, less, or the same amount of sunlight as point B? Point A and B are the same distance away from the equator.

Tilt of planet = sideways (97.77°)



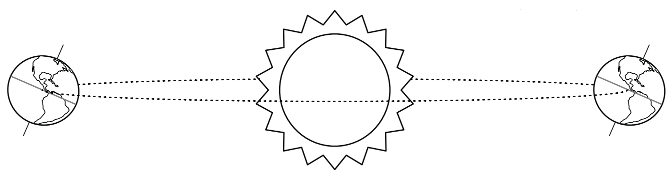
A planet with an extreme tilt of 97° undergoes 1 complete rotation in 24 hours. During that time, will point A receive more, less, or the same amount of sunlight as point B? Points A and B are the same distance away from the equator.

Earth is tilted at 23.5 degrees

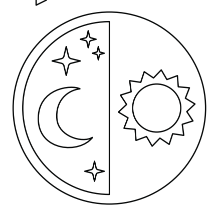


Earth has a tilt of 23.5° and completes 1 rotation every 23 hours and 56 minutes. During that time, will point A receive more, less, or the same amount of sunlight as point B? Point A and B are the same distance away from the equator.

Solstice



Equinox



DEFINITION: ______________________________

____

____

____

DEFINITION: ______________________________

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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.