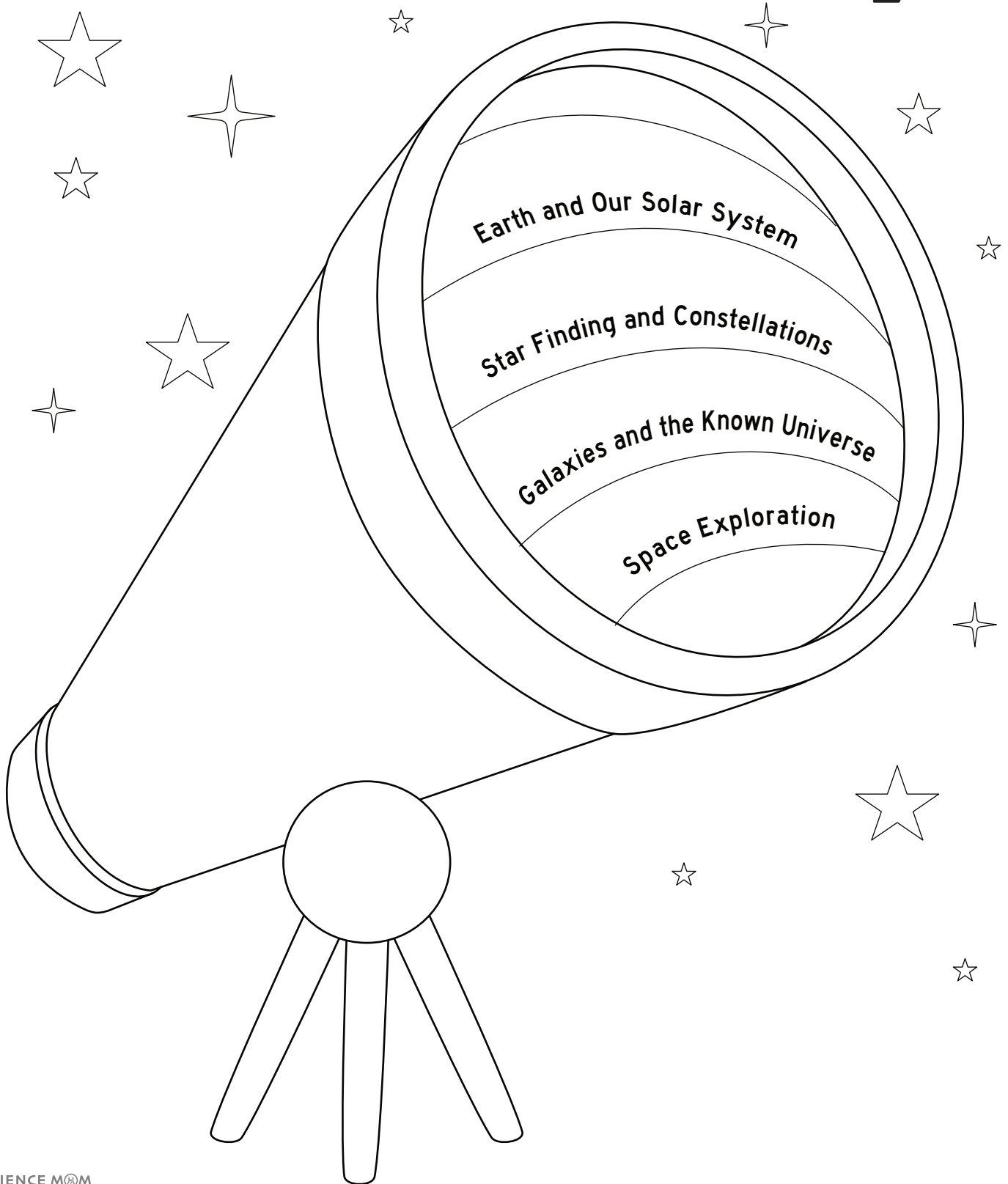


Astronomy



ASTRONOMY

Unit	Lesson	Date	Topic	Pages
Unit 1. Earth and the Moon	1	Mon, Jan 13	What Is Astronomy?	4-5
	2	Wed, Jan 15	Diurnal Motion	6-7
	3	<i>Self paced lesson</i>	<i>Finding your latitude</i>	8-9
	4	Mon, Jan 20	<i>No Class (MLK day holiday)</i>	
	5	Wed, Jan 22	Seasons	10-11
	6	<i>Self paced lesson</i>	<i>Making a Sundial</i>	12-13
	7	Mon, Jan 27	Our Moon	14-15
	8	Wed, Jan 29	Eclipses	16-17
	9	<i>Self paced lesson</i>	<i>Moon Chart and Review</i>	18-21
	10	Mon, Feb 3	EARTH & MOON QUIZ SHOW	
Unit 2. Our Solar System	12	Wed, Feb 5	Our solar system:Scope and Story	22-23
	13	<i>Self paced lesson</i>	<i>Step-scale model of the solar system</i>	
	14	Mon Feb 10	The Inner and Outer Planets	
	15	Wed Feb 12	Asteroids	
	16	<i>Self paced lesson</i>	<i>Flour and Cocoa Craters</i>	
	17	Mon Feb 17	Motion of the Planets	
	18	Wed Feb 19	Comets and meteors	
	19	<i>Self paced lesson</i>	<i>Dry ice comets OR meteor art</i>	
	20	Mon Feb 24	Near Earth Objects	
	21	Wed Feb 26	SOLAR SYSTEM QUIZ SHOW	
			<i>Review</i>	
			<i>SPRING BREAK is March 10-15</i>	
			Final Day of class = May 7	

Full Schedule Coming Soon!
 Unit 3 = star finding and constellations
 Unit 4 = Galaxies and the known universe
 Unit 5 = Space Exploration

Supply list and more coming here later...


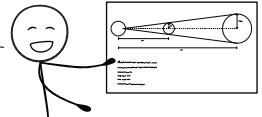

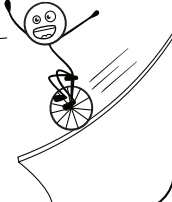
What is Astronomy?

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:

<p>YOUR BIRTHDAY IS ON FEB 28. THAT MEANS YOU'LL LOVE SWIMMING!</p> 	<p>AT THIS LOCATION, THE TOTAL ECLIPSE WILL BE EXACTLY 3 MIN AND 42 SECONDS.</p> <p>MATH.</p>  <p>HOW CAN YOU KNOW THAT!?</p>	<p>I CAN'T MARRY YOU BECAUSE I'M A GEMINI AND YOU'RE A SCORPIO. OUR SIGNS ARE INCOMPATIBLE!</p> 	<p>DON'T WORRY —MY HOROSCOPE SAID TODAY WAS A GOOD DAY FOR TAKING RISKS!</p> 
<p>_____</p>	<p>_____</p>	<p>_____</p>	<p>_____</p>

IS IT SCIENCE OR PSEUDOSCIENCE?

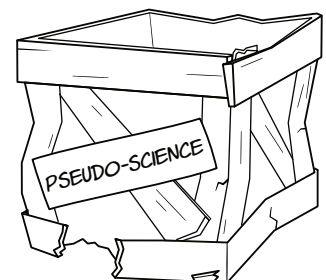
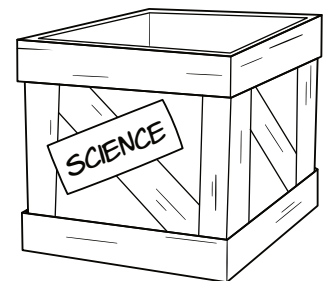
Match each characteristic with the appropriate box

Relies on anecdotal evidence

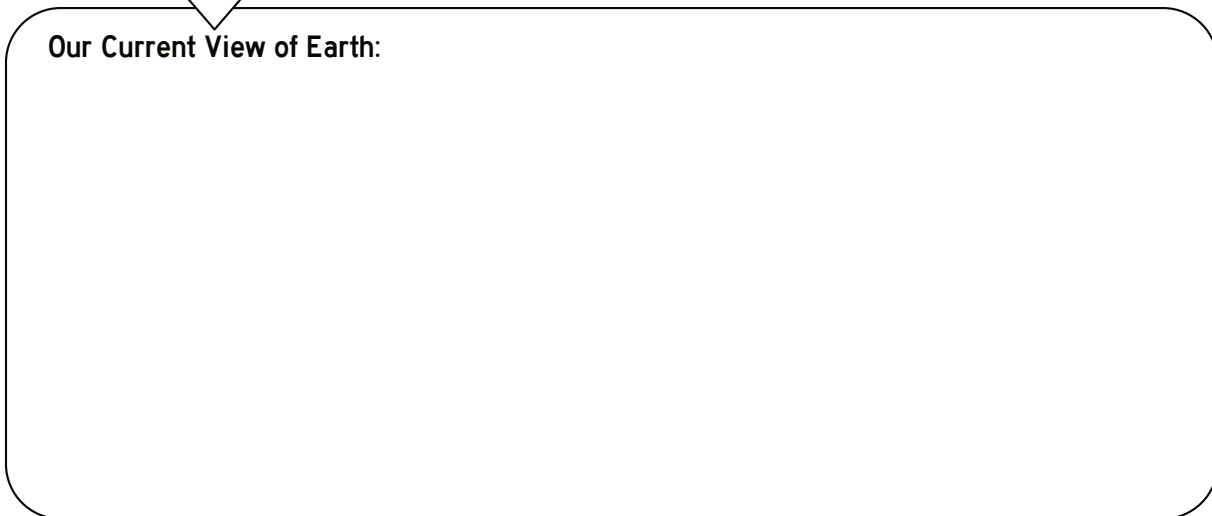
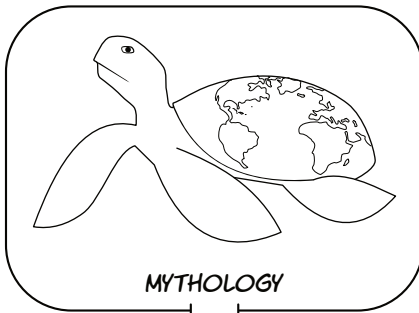
Relies on data (controlled studies and reproducible observations)

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



Aristotle *approximately 350 BCE*

Eratosthenes *approximately 250 BCE*

ALEXANDRIA SYENE

ANGLE OF SUNLIGHT

Ptolemy *approximately 150 CE*

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

LAND APPEARS "TOP FIRST" WHEN COMING HOME FROM SEA

50 km from land

40 km from land

30 km from land

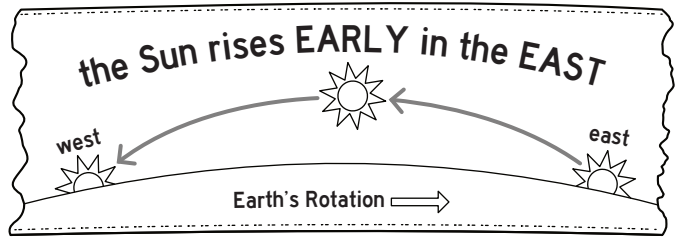
1 km from land



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 this same path in 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

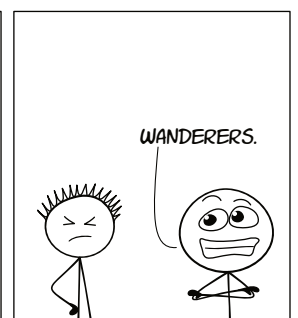
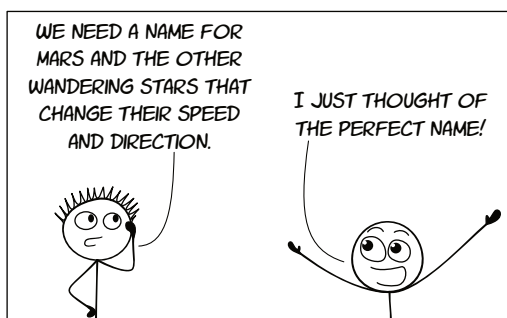
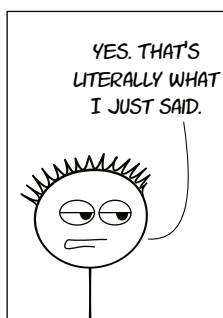
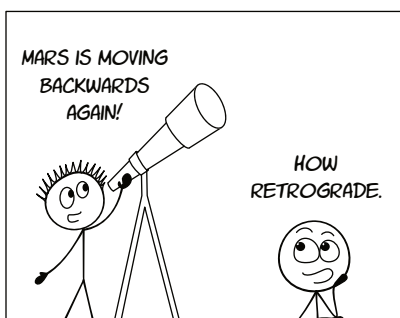
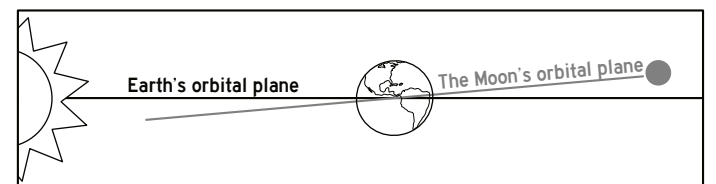
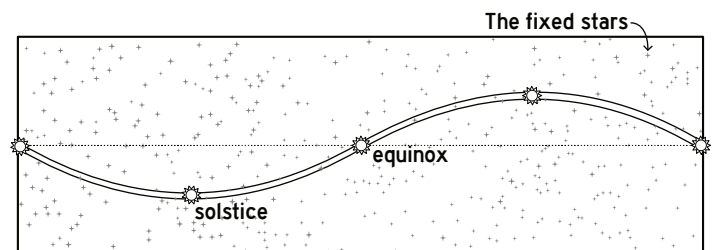
The ISS

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* (Πλάνητες) which means "wanderer."

Use the word bank to label each graphic with the correct term.

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

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

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 ASTRONOMICAL OBJECTS

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

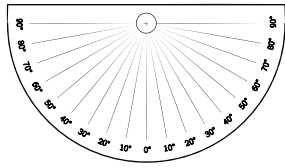
HALF OF A SPHERE

Finding Your Latitude

MATERIALS



6 inches of thread or string



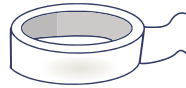
Protractor template



Pin



Washer or other weight



Tape



1 straw

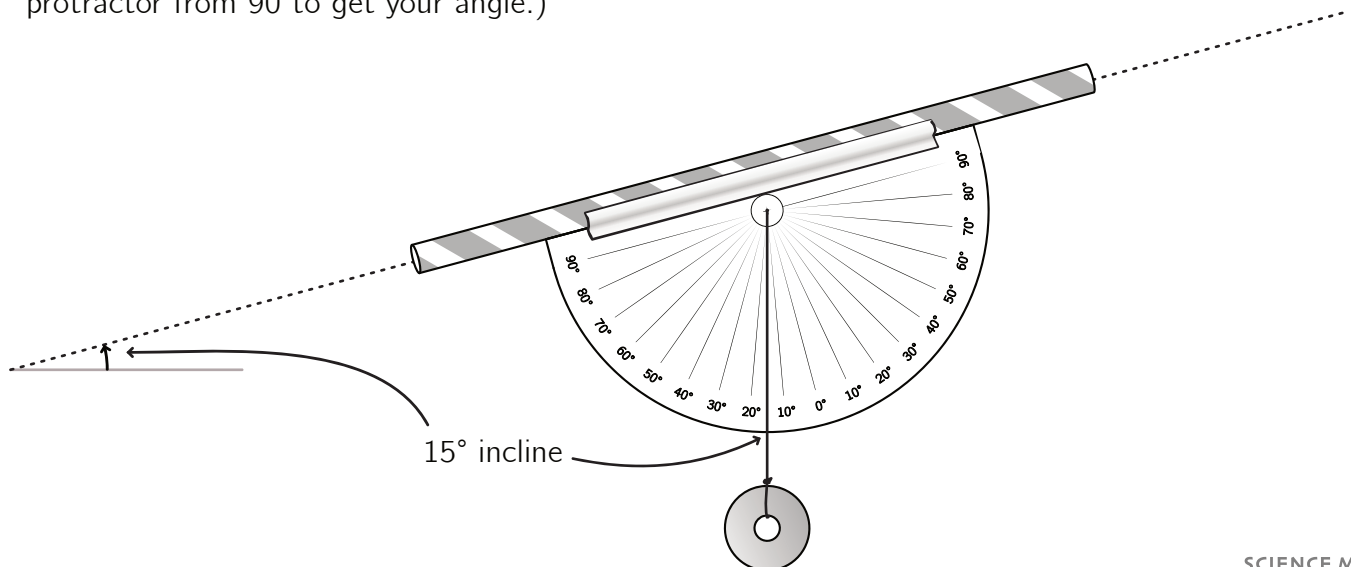
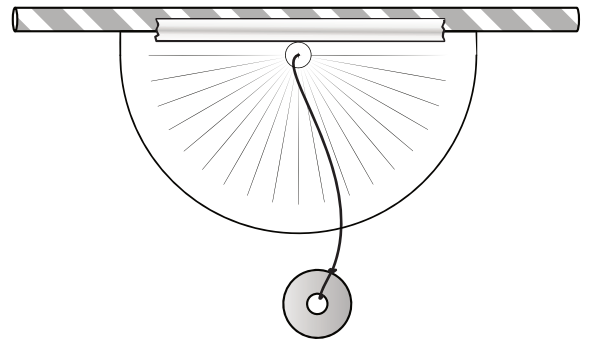
GOALS

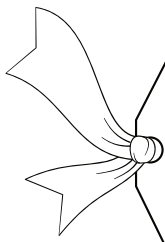
- ★ Build a device to measure the angle of incline of a distant object.
- ★ Find the latitude of your current location.

Inclinometer

An inclinometer helps you to measure the angle or inclination of an object. With a little bit of geometry, we can use an inclinometer to find the latitude of our current location.

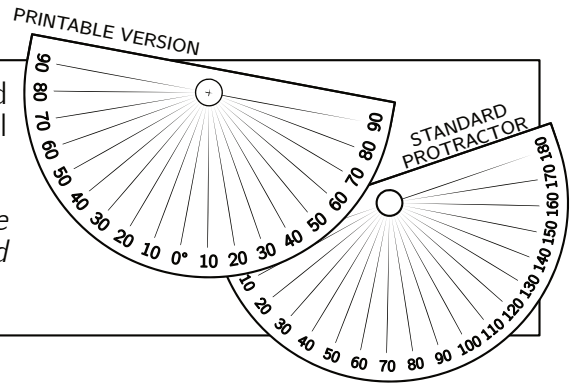
1. Print the protractor template from the appendix OR locate your own standard protractor. If using the printable version, be sure to cut it out carefully so that you get a straight edge.
2. Use a pin or a nail to poke a hole in the center of the protractor on the plus sign.
3. Feed a small amount of the string through the hole and tape it in place on the back.
4. Tie a washer or some other weight to the other end of the string.
5. Tape the protractor along the edge of the straw. Now you have created an inclinometer.
6. Hold the inclinometer in front of one eye and sight your distant target. Be careful to place it exactly in the center of the sight.
7. The string should be dangling straight down. The value of the angle where the string meets the protractor is the angle of ascension relative to your eye. (If your protractor is labelled differently, you may need to subtract the number on the protractor from 90 to get your angle.)





NOTE: The printable protractor has angles labeled with $90^\circ - x$. This means the angle of inclination will match where the string crosses the edge.

If using a standard protractor, you will need to take the angle where the string crosses the edge and then subtract it from 90° .

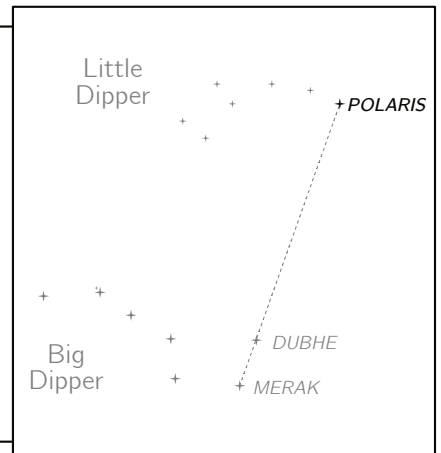


Finding Your Latitude

You can use the inclinometer to find your latitude! First locate the Polaris (the North Star). Use an app such as Sky Guide or find it 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.

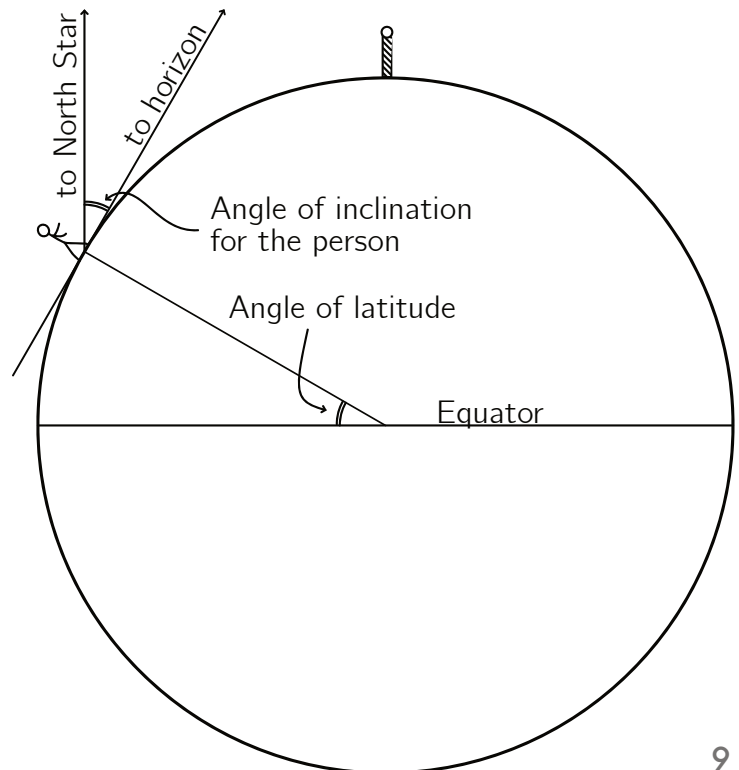
Look at Polaris through your straw and hold the inclinometer steady with the string hanging freely down. Your angle of inclination is where the string crosses the curved edge of the printable protractor.

Note: if you are in the Southern Hemisphere, don't use the North Star! Instead, find Sigma Octantis (also called Polaris Australis)

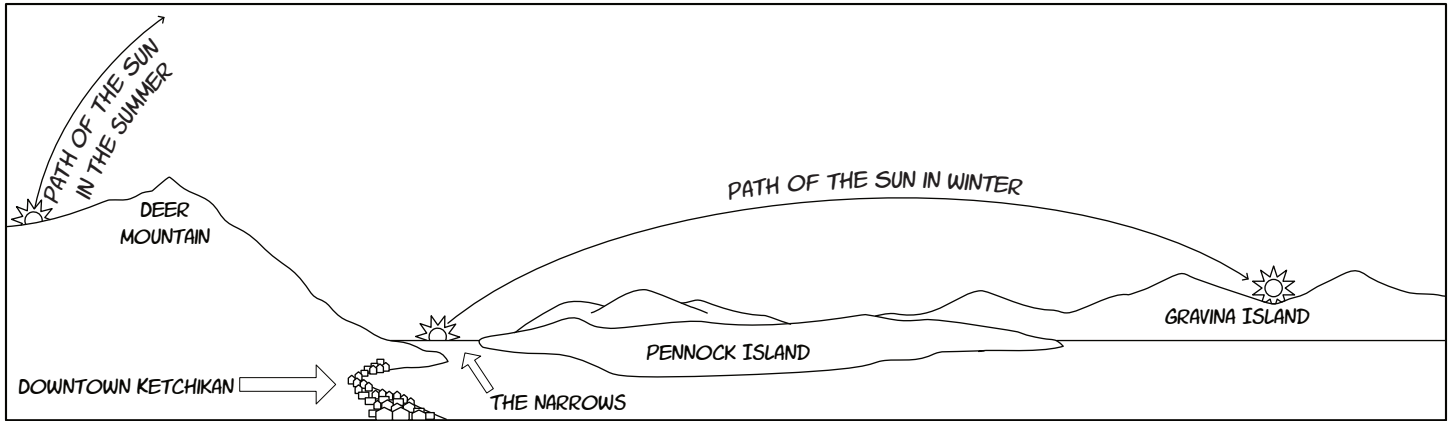


Once you have measured your angle, answer the questions below. Use another page to write if needed.

1. At your location, what is the angle of inclination to the North/South Star?
2. Look up your actual latitude using an online map.
3. Did the angle of inclination match your latitude? If not, what do you think went wrong?
4. Why should the angle of inclination to the North Star should be equal to your latitude on Earth?



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!

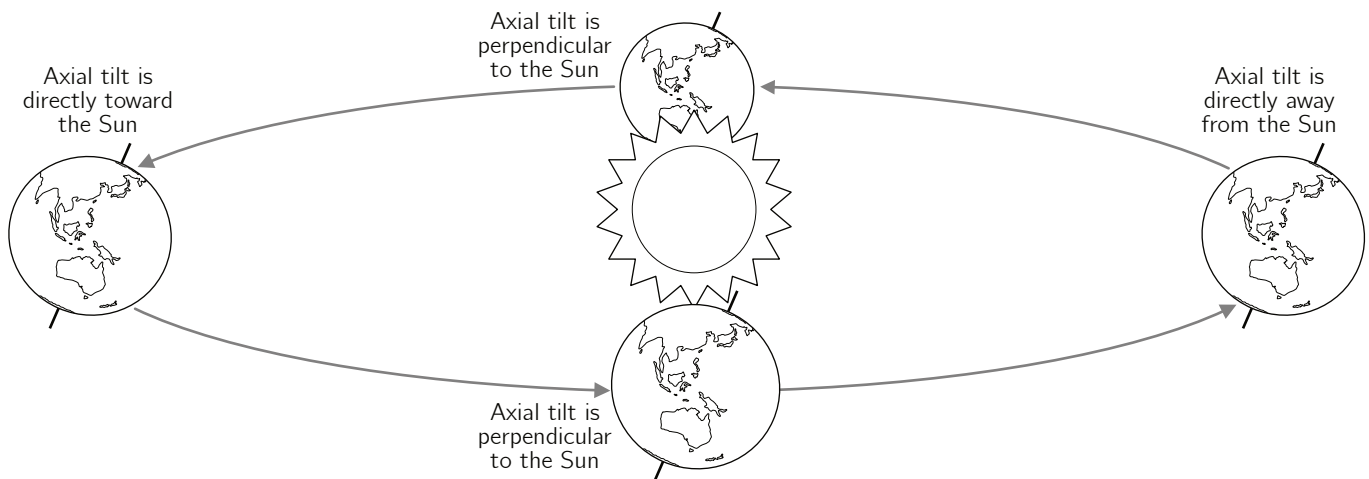
What seasonal differences in the position of the Sun have you observed where you live? When and where does the Sun rise and set? Where is the Sun in the sky at noon?

During winter: _____

During summer: _____

Four points in Earth's orbit are described in the diagram below. Label each with the correct equinox or solstice for the Northern and Summer Hemisphere. Also include the approximate date.

Note: Distance and size are not to scale.



A Tale of Five Cities

Fairbanks, USA
64°50' N 147°43' W

	Sunrise	Sunset	Amount of daylight
Jun 21	2:57 am	12:47 am	
Sep 21	7:32 am	7:52 pm	
Dec 21	10:58 am	2:40 pm	
Mar 21	7:45 am	8:11 pm	

Havana, Cuba
23°08' N 82°21' W

	Sunrise	Sunset	Approximate hrs of daylight
Jun 21	6:44 am	8:18 pm	
Sep 21	7:18 am	7:26 pm	
Dec 21	7:06 am	5:49 pm	
Mar 21	7:32 am	7:41 pm	

Singapore, Singapore
1°17' N 103°51' E

	Sunrise	Sunset	Approximate hrs of daylight
Jun 21	7:00 am	7:12 pm	
Sep 21	6:54 am	7:00 pm	
Dec 21	7:01 am	7:04 pm	
Mar 21	7:08 am	7:15 pm	

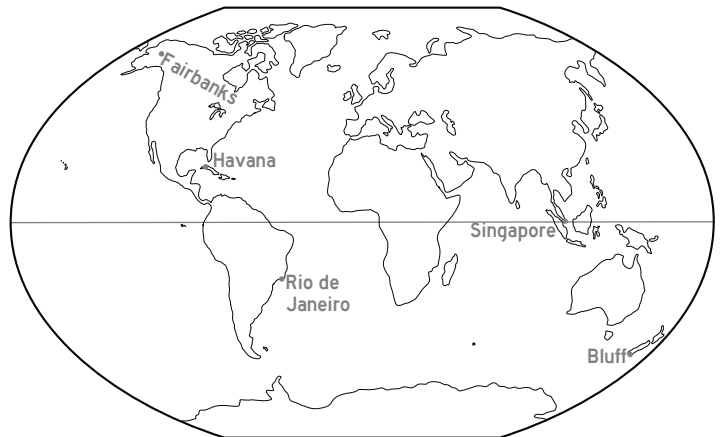
Rio de Janeiro, Brazil
22°57' S 43°12' W

	Sunrise	Sunset	Approximate hrs of daylight
Jun 21	6:33 am	5:16 pm	
Sep 21	5:42 am	5:48 pm	
Dec 21	5:04 am	6:37 pm	
Mar 21	5:56 am	6:01 pm	

Bluff, New Zealand
46°36' S 168°20' E

	Sunrise	Sunset	Approximate hrs of daylight
Jun 21	8:31 am	5:05 pm	
Sep 21	6:37 am	6:42 pm	
Dec 21	5:49 am	9:39 pm	
Mar 21	7:49 am	7:57 pm	

Sunrise and sunset times are from timeanddate.com for 2024 and 2025 (March)

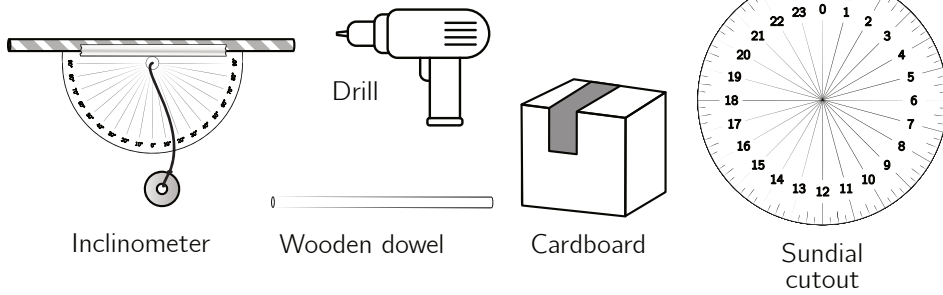


Is there a day of the year where a post would cast NO shadow because the Sun is directly overhead?
If so, which city and which day(s)?

Havana and Rio de Janeiro are near the Tropic of Cancer and Tropic of Capricorn, respectively. What is significant about 23° N and 23° S?

A Working Sundial

MATERIALS



GOALS

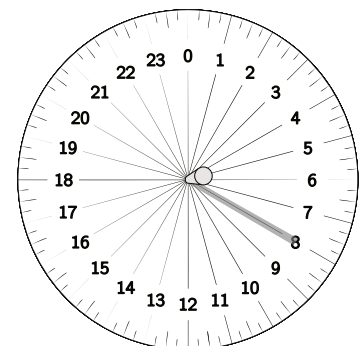
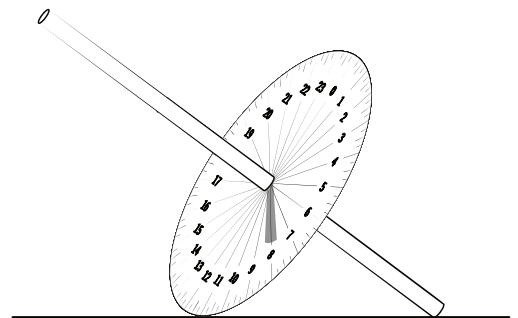
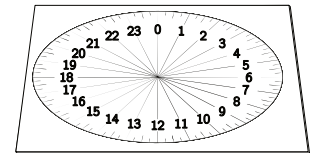
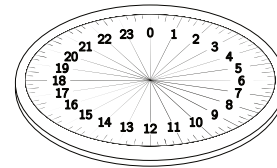
- ★ Learn more about the Sun's path and Earth's orbit by building a working sundial.
- ★ Adjust your sundial to give accurate time by considering various factors.

Equatorial Sundial

A sundial is a device that tells time. It consists of a rod (called a gnomon) that casts a shadow on a flat plane (called the dial) that has markings to indicate the time.

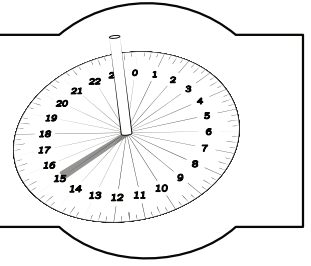
Instructions:

1. Print the sundial cutout from the appendix and cut it out.
2. Glue or tape it to a solid backing such as cardboard so that it is rigid and sturdy.
3. Drill a hole in the center of the dial so that the dowel fits snugly in the hole but can be slid in or out. The backing should be sufficiently thick and rigid so that it holds the rod perpendicular to the face of the dial without tipping.
4. If you are in the Northern Hemisphere, point the dial so that the gnomon is pointed directly at the North Star (For Southern Hemisphere, point the gnomon to Polaris Australis). Slide the gnomon in or out so that the dial rests on the ground with the gnomon still pointed at the North Star. The easiest way to do this is to locate the North Star with the inclinometer and note the exact angle. Then use the inclinometer protractor as a reference to maintain the same angle.
5. You'll be making adjustments during the day, so you'll need to mark the ground by the sundial to show the direction of true north. (This is different than magnetic north which you would get from a compass.)
6. On the hour (e.g. 8:00 am) rotate the dial so that the center of the shadow is at 8:00 on the sundial. However, you must do this in such a way that the gnomon remains pointing to the North Star. Verify that your gnomon is still pointed at the angle you found on the inclinometer in step 4 (which should match your latitude) and is also pointed in the direction of true north.
7. Now the exact center of the shadow will give the correct solar 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 a working sundial that is flat on the ground, look up information on analemmatic sundials.



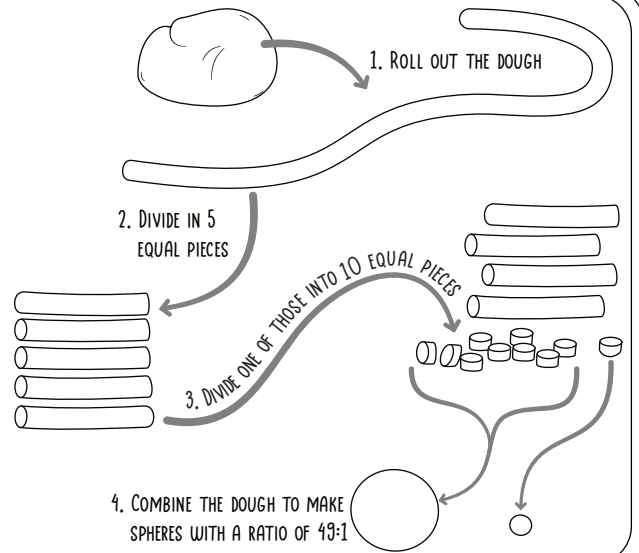
- ① When you placed your sundial outside, did it accurately tell the time? Check on it over several days or weeks to see how it does. What factors might cause discrepancies between the sundial time and standard clock time?
- ② Would your sundial work if located at the North Pole or South Pole Why or 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?

THE MOON: Earth's closest friend

Make a Model

Earth and its moon are often illustrated so the distance and size are NOT to scale. Here's a great modeling exercise to help better appreciate how the Earth-Moon system is actually scaled. All you need is a lump of play dough.

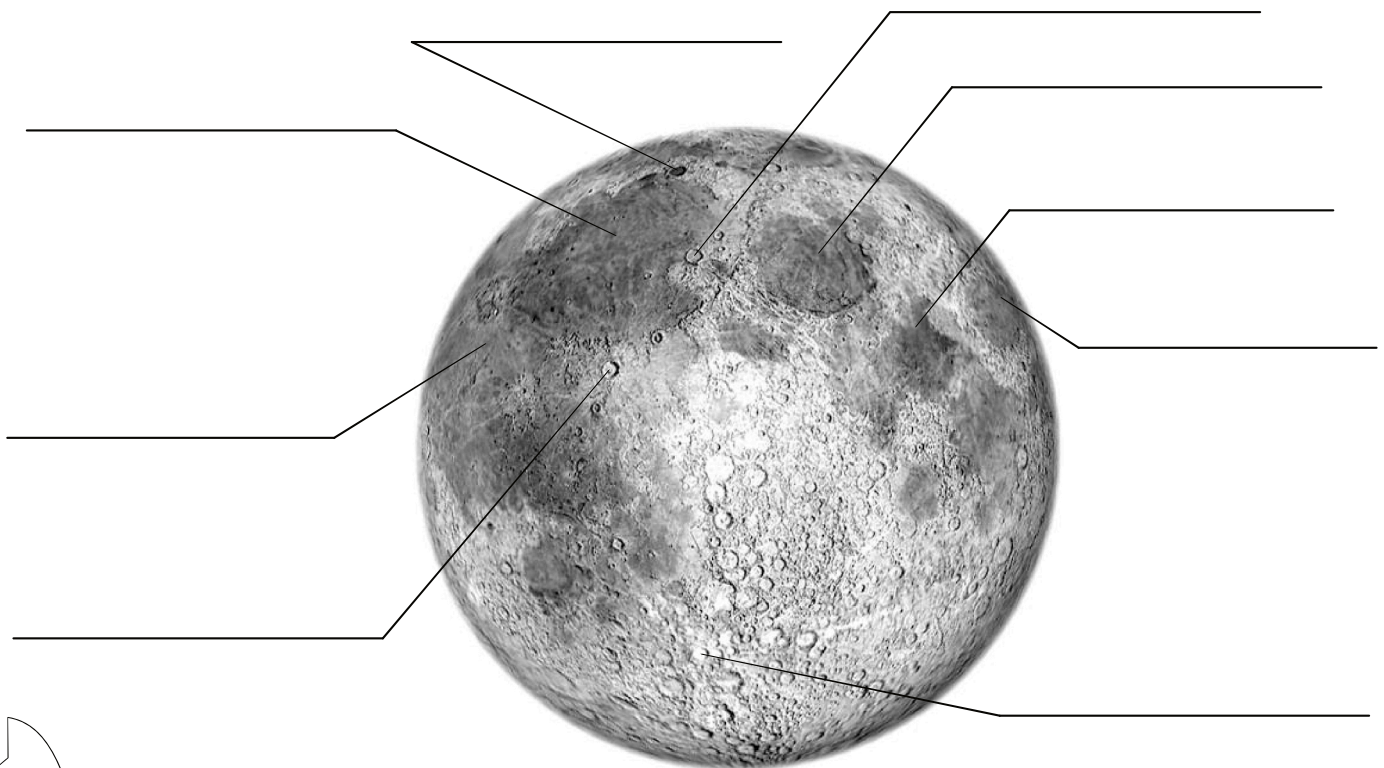
1. Roll the play dough into a cylinder and divide it into five equally-sized portions.
2. Then divide one of those pieces into 10 equal size pieces.
3. Remove one of the small portions and roll it into a sphere. This sphere represents the Moon.
4. Combine the rest of the play dough and roll it into a sphere. This sphere represents the Earth.
5. Measure the diameter of the model Earth. Then place the Moon 30 diameter-lengths away from the Earth. You now have a scaled model of the Earth and Moon!



The Near Side 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.

Using the descriptions on the opposite page or online resources, label the features below:



IN OUR SOLAR SYSTEM, THE _____ IS THE _____ OBJECT THAT SHINES WITH ITS OWN LIGHT.

Observe the Moon when it is NOT a full moon. How many of these features can you find?

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

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

Mare Imbrium - This mare was formed when lava flooded a giant crater. It is surrounded by large mountains, some of which are 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 - The only mare called an "ocean" due to its enormous size. Not associated with a crater or impact event.
Diameter: between 2,000 to 3,000 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

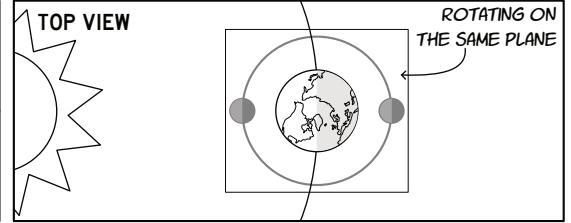
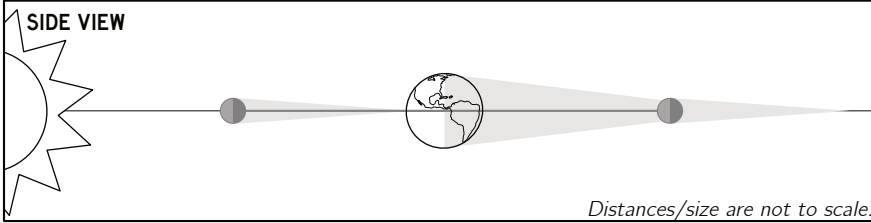
Tycho - This distinctive crater is surrounded by bright rays that extend outward in all directions. Some are over 1,500 km long!
Diameter: 85 km

Color and label each phase of the Moon:

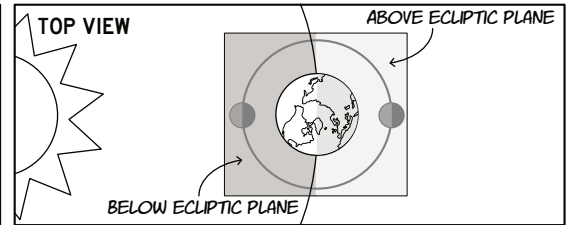
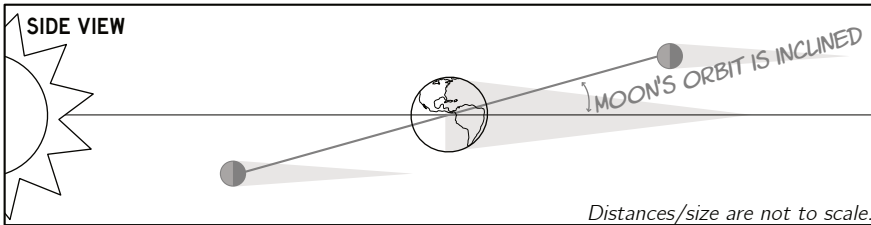
The new moon has been filled in as an example. Use the sun chart to help!

SHADE THE ENTIRE MOON! 			
NEW MOON			

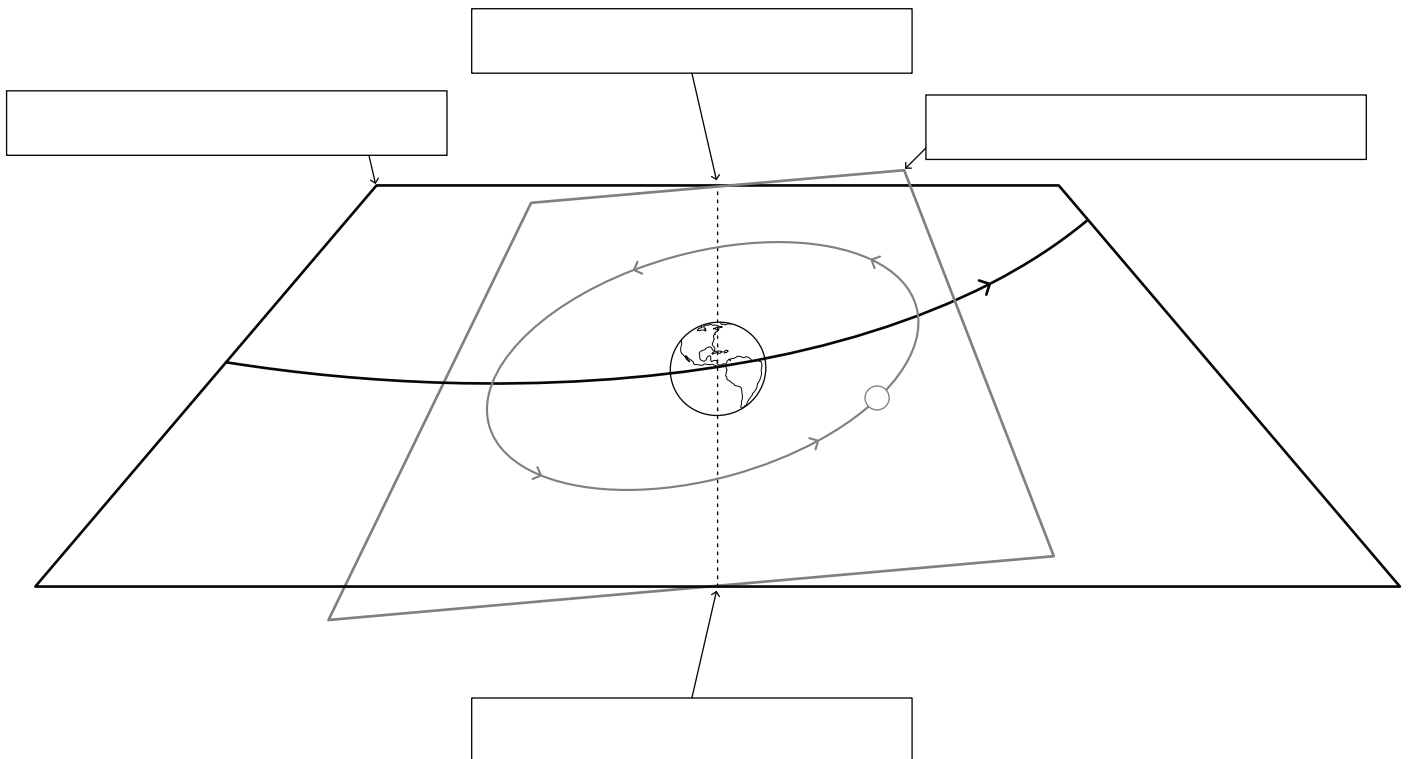
ECLIPSES: partial, total, lunar, and solar



If the Moon, Earth, and Sun were all on the exact same plane, when would we see solar and lunar eclipses?



If the Moon, Earth, and Sun were NOT on the same plane, when would we see solar and lunar eclipses?



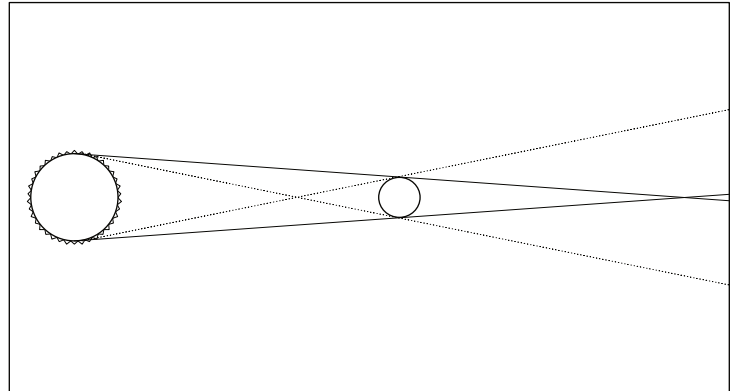
When sunlight shines on an opaque object, it casts a shadow. Most shadows have 3 parts:

Umbra: _____

Penumbra: _____

Antumbra: _____

Color in and Label the umbra, penumbra, and antumbra:



Where is the Sun being observed from? The umbra, penumbra, or antumbra?

PART OF THE SUN IS BLOCKED.	NONE OF THE SUN IS VISIBLE.	PART OF THE SUN IS BLOCKED.
_____	_____	_____

Solar eclipse or lunar eclipse? Draw lines to match each description with the best fit.

The Moon is positioned directly between the Sun and the Earth	The Earth is positioned directly between the Sun and the Moon	Usually visible in a narrow area between 100 to 200 km wide	Usually visible in a large area such as an entire hemisphere of the Earth
<div style="border: 1px solid black; border-radius: 15px; padding: 10px; display: inline-block;">SOLAR ECLIPSE</div>		<div style="border: 1px solid black; border-radius: 15px; padding: 10px; display: inline-block;">LUNAR ECLIPSE</div>	
Can only occur during the FULL MOON phase	Can only occur during the NEW MOON phase	Usually lasts for a couple of minutes	Usually lasts for a couple of hours

Earth & Moon Review

IN YOUR OWN WORDS!

Learning and understanding new words is an important part of astronomy! Define each of the following terms in your own words. If the word has a box next to it, use that space to draw and label a diagram.

APHELION: _____

PERIHELION: _____

EQUATOR and PRIME MERIDIAN: _____

EQUINOX: _____

SOLSTICE: _____

MATCH THE WORD WITH THE CORRECT DEFINITION

ECLIPTIC

LATITUDE

LONGITUDE

ORBIT

REVOLVE

ROTATE

SYZYGY

ZENITH

The angle between the direction of gravity and the plane of the Earth's equator; measures the distance north or south of the equator

Measures the east-west position of a point on Earth's surface

A repeating path that one object in space takes around another object, usually following an elliptical shape

The Sun's apparent path across the sky; the plane that contains both the Sun and Earth's orbit

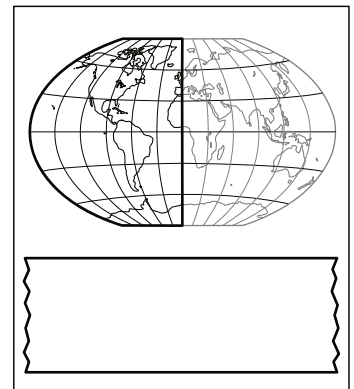
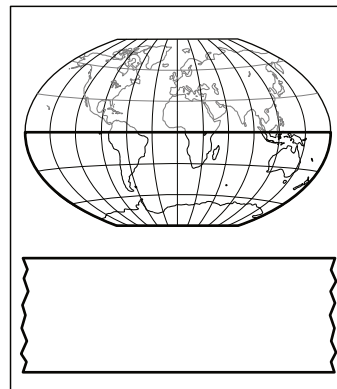
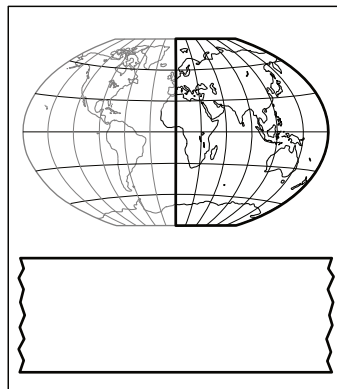
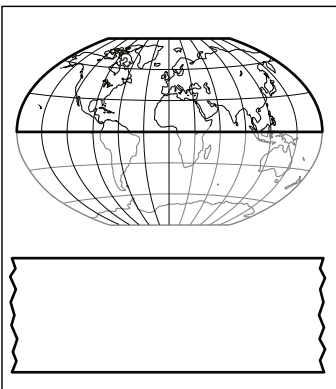
To spin or move around an axis or center

When two or more objects are in a straight line; often used to describe the arrangement at full and new moon

The highest point

To move in a circular path around an object; to orbit around something

LABEL THE HEMISPHERES



- ① What is true about **astronomy**? (mark all that apply)
- A. It is considered to be one of the branches of modern science
 - B. It is used to produce daily horoscopes
 - C. It relies heavily on mathematics and physics
 - D. It is used to study the physical properties of stars and planets

- ② What is true about **astrology**? (mark all that apply)
- A. It has lore and traditions surrounding the constellations that lie along the ecliptic
 - B. It relies heavily on mathematics and physics
 - C. It is considered to be one of the branches of modern science
 - D. It is used to produce daily horoscopes

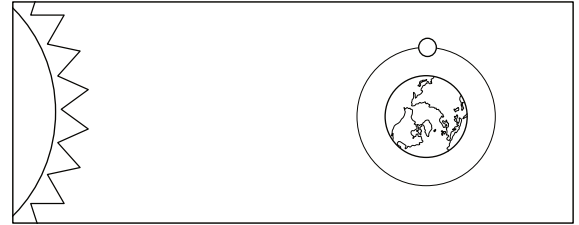
- ③ As seen from locations in the Northern Hemisphere, most stars set in the:
- A. North
 - B. East
 - C. South
 - D. West

- ④ When the Sun is observed in the sky from the *Southern Hemisphere*, in which direction does it reach its highest point or zenith?
- A. North
 - B. East
 - C. South
 - D. West

- ⑤ What is the reason Earth has seasonal variations in daylight and temperature? In other words, what is the primary cause of spring, summer, autumn and winter?
- A. Earth has an elliptical orbit
 - B. Earth rotates on a tilted axis
 - C. The Moon causes changes as it orbits
 - D. The Sun varies in brightness over the course of a year

- ⑥ When the Sun is observed in the sky from the *Northern Hemisphere*, in which direction does it reach its highest point or zenith?
- A. North
 - B. East
 - C. South
 - D. West

- ⑦ Which of the following statements about the Moon are true?
- A. It rotates faster than the Earth
 - B. Its “dark side” always faces away from the Earth
 - C. The darker patches on the face of the Moon have higher elevation than the lighter patches
 - D. The moon does not rotate



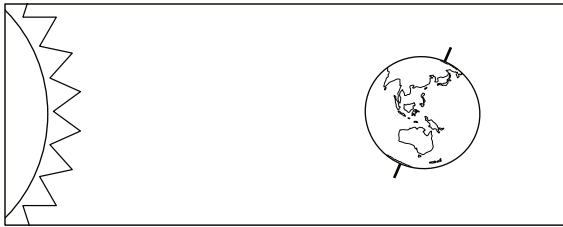
- ⑧ What phase of the Moon is visible if the Sun, Moon, and Earth are positioned as pictured above?
- A. Full moon
 - B. Crescent or gibbous
 - C. Quarter
 - D. New moon

- ⑨ The Moon goes through a complete cycle of its phases approximately:
- A. Daily
 - B. Weekly
 - C. Monthly
 - D. Yearly

- ⑩ A **lunar eclipse** can only occur during which Moon phase?
- A. New moon
 - B. Crescent moon
 - C. Quarter moon
 - D. Full moon

- ⑪ What is the term for the line of latitude at 23.5° North?
- A. Arctic Circle
 - B. Antarctic Circle
 - C. Tropic of Cancer
 - D. Tropic of Capricorn

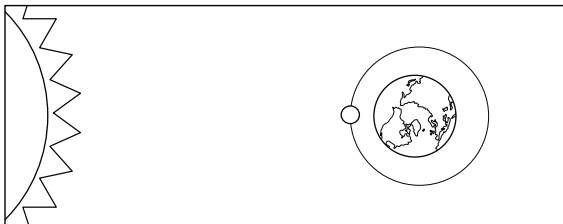
- ⑫ When is the autumn equinox in the *Southern Hemisphere*?
- A. December
 - B. March
 - C. September
 - D. June



- 13 In the illustration above, is the Southern Hemisphere experiencing winter or summer?
- A. Winter
 - B. Summer
 - C. Neither

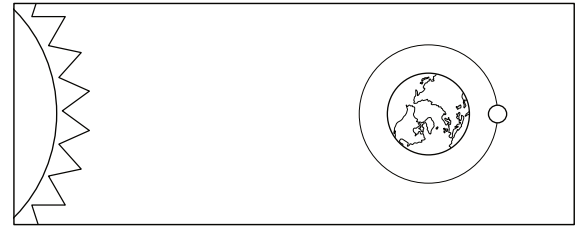
- 14 A **solar eclipse** can only occur at what phase of the Moon?
- A. New moon
 - B. First quarter
 - C. Full moon
 - D. Last quarter

- 15 The dark areas on the Moon's surface are best described as:
- A. Craters
 - B. Lava plains
 - C. Mountains
 - D. Oceans

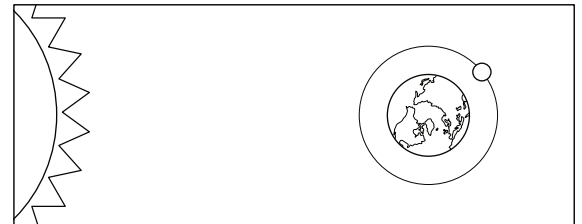


- 16 What phase of the Moon is visible if the Sun, Moon, and Earth are positioned as pictured above?
- A. Full moon
 - B. Crescent or gibbous
 - C. Quarter
 - D. New moon

- 17 What is the name for the lighter outer part of a shadow?
- A. Umbra
 - B. Penumbra
 - C. Antumbra



- 18 What phase of the Moon is visible if the Sun, Moon, and Earth are positioned as pictured above?
- A. Full moon
 - B. Crescent or gibbous
 - C. Quarter
 - D. New moon



- 19 What phase of the Moon is visible if the Sun, Moon, and Earth are positioned as pictured above?
- A. Full moon
 - B. Crescent or gibbous
 - C. Quarter
 - D. New moon

- 20 The gnomon on a sundial is:
- A. The curved part where the time is marked
 - B. The shadow-casting bar or post
 - C. The compass used to align the sundial
 - D. The base of the sundial

LABEL EACH DESCRIPTION WITH THE CORRECT TYPE OF ECLIPSE (Annular, partial, or total and either lunar or solar)

The type of eclipse that occurs when the Moon is too far from Earth to completely cover the Sun, leaving a "ring of fire."

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Also called a "Blood Moon," this eclipse occurs when the Earth moves directly between the Sun and the Moon.

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This type of eclipse produces crescent-shaped shadows on the ground.

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