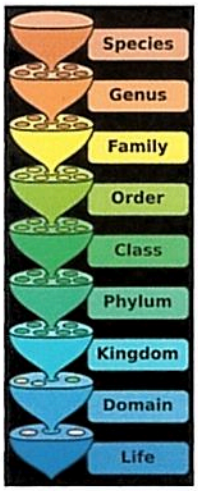
Earth Science Honors

Earth Science Project- Unit 1: Prologue

Classification



- Grouping objects or observations based on similarities and differences
- Also known as Binomial Nomenclature
  - Kingdom →Phylum →Class→ Order→ Family→ Genus→ Species
- The flow chart seen above shows the different groups of classification
- Different organisms are usually called by their Genus and Species.
  - For example: Homo sapiens
  - This is the Genus and species of a human. Genus is capitalized, species is not.

Dimensional Quantities

- Length- measured with a meter stick or a ruler and has the units of a meter, centimeter, millimeter, and/or kilometers.
  - Area- the length multiplied by the width. The answer for this will always be units^2
- Volume- the amount of space an object takes up
  - Units are cm^3 for solids but mL for liquids
  - A regular solid that can be measured is length X Width X height
  - An irregular solid you must use water displacement
  - Water displacement
    - Immerse and object in a graduated cylinder and note the amount of water that rises.

Observation (Qualitative vs. Quantitative)

- An observation is any fact or data that is obtained by using one of the five senses
- Qualitative: when collected data is evaluated with an overall distinction (when it is different than something else)
  - For example: the bird is small
- Quantitative: When collected data can be expressed numerically
  - For example: The bird's height is 18 inches.
- Observations are used to classify objects – classification

Measurement

- Systeme Internationale (SI) is the system of units used around the world except for a few countries. It is commonly known as the metric system.

Density

- A measure of the amount of matter that is crammed into the space of an object occupies
- Units are g/cm^3 for solids but g/mL for liquids

Factors that Affect Density

- Temperature
  - As this increases the particles move faster. Therefore, increasing volume and decreasing density.
- Pressure
  - As this increases, particles are pushed closer together and the mass takes up less space and density increases

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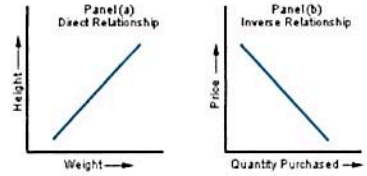
Cyclic and Non-Cyclic Changes

- Cyclic changes
  - These types of changes are repeating
- Non-Cyclic changes
  - Direct Relationship
    - As X gets bigger, y gets bigger
  - Indirect Relationship
    - As X gets bigger, Y gets smaller
  - Static Relationship
    - X has no effect on y. The line of the graph will be parallel to the x-axis

Figure 1 - Relationships



Rate of Change

- The speed at which changes of a system occur
- Slopes and Rate of Change
  - Steep = greater Rate of Change (ROC)
  - Gentle = slower ROC
  - None = No change
- ROC= Change in field value divided by time

Equations

$$\text{Eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

$$\text{Gradient} = \frac{\text{change in field value}}{\text{distance}}$$

$$\text{Rate of change} = \frac{\text{change in value}}{\text{time}}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Dynamic Equilibrium

- Equilibrium- a balance between **opposing forces**
- **Dynamic** Equilibrium- a balances between **changes**

Event

- When the proper ties of matter or a system are altered

Interface

- A boundary where energy is exchanged
- CHANGE OCCURS HERE

Frame of Reference

- A basis for comparison
- A frame of reference is needed to make any measurements and to record change
- For example, when measuring distance traveled you can make your frame of reference at the point from where you started to travel.
  - It can be a tree if you start at a tree

Lithosphere

- The crust of the Earth
- The solid sphere of Earth
- The bottom of the three spheres
- Made of solid rock and liquid iron and nickel in the outer core

Hydrosphere

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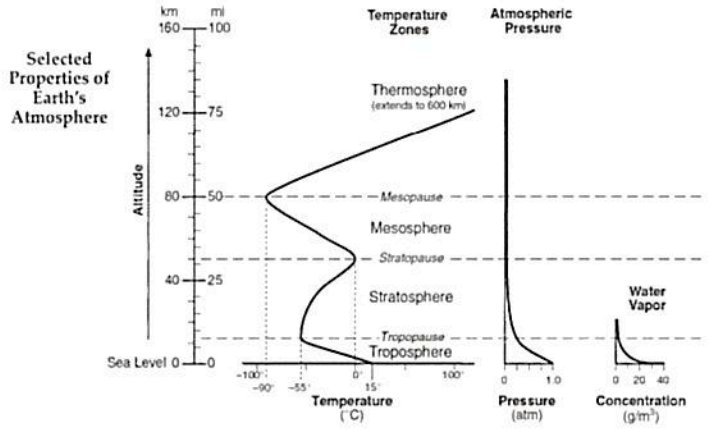
- The oceans and seas
- The liquid sphere of Earth
- The middle of the three spheres
- Home to amphibians, and underwater sea creatures



Atmosphere

- The air of Earth
- The gaseous sphere of the Earth
- The top of the three spheres
- It is divided into 4 sub-spheres
    - Troposphere
        - Bottom layer
        - Where weather occurs
        - Most of the atmospheres water vapor is here
        - Temperatures decrease of altitude increases
    - Stratosphere
        - Second layer
        - Temperatures are increasing as altitude increases
    - Mesosphere
        - Third layer
        - Temperatures are decreasing as altitude increases
    - Thermosphere
        - Top layer
        - Temperatures are increases as altitude increases
        - Extends from 80 km to 600 km
        - This is the last layer of the atmosphere, outer space is beyond this

Pollution (polluted and pollutants)

- Natural pollutants
    - Ash and dust in atmosphere from Volcanic eruptions
- Environmental Pollutants
    - Solids
    - Liquids
    - Gases
    - Energy forms
        - Heat
        - Sound
        - Nuclear radiation

Independent Variable

- The variable on the x axis
- This variable does not depend on the variable on the y axis, hence INDEPENDENT variable

Dependent Variable

- The variable on the y axis

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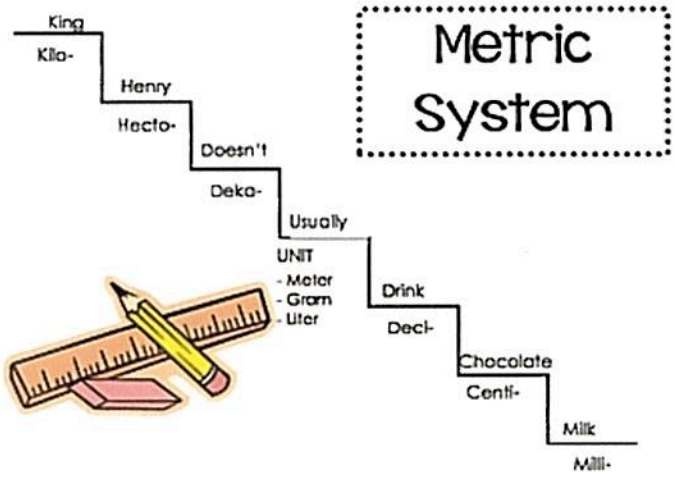
- This variable depends on the variable on the x axis, hence DEPENDENT variable
- Time is usually a dependent variable

Interval

- A space between things, points or limits

Metric System

- Also known as Systeme Internationale
- Measurement prefixes known as:
  - Milli
  - Centi
  - Kilo
- Units used are g (gram), L (liter), m (meter)



Converting in the Metric System

- Converting from a smaller number to a bigger number
  - Divide your number by 10
- Converting from a bigger number to a smaller number
  - Multiply your number by 10

Percent Error (deviation)

- Percent Error = $\frac{difference\ from\ accepted\ value}{accepted\ value}$ X 100
- This determines how wrong a measurement is

$$\% \text{ Error} = \left| \frac{\text{measured - accepted}}{\text{accepted}} \right| \text{x100}$$

Metric Conversion

King	Henry	Died	Unusually	Drinking	Chocolate	Mi
Kilo	Hecto	Deca	* Unit *	Deci	Centi	Milli
10 x 10 x 10 x LARGER than a unit	10 x 10 x LARGER than a unit	10 x LARGER than a unit	*Meter* (length) *Liter* (liquid volume) *Gram* (mass/weight)	10 x SMALLER than a unit	10 x 10 x SMALLER than a unit	10 x 10 x SMALLI than a u
1 kilo = 1,000 units	1 hecto = 100 units	1 deca = 10 units	1 unit	10 deci = 1 unit	100 centi = 1 unit	1,000 n = 1 ur
km = kilometer kL = kiloliter kg = kilogram	hm = hectometer hL = hectoliter hg = hectogram	dam = decameter daL = decaliter dag = decagram	m = meter L = liter g = gram	dm = decimeter dL = deciliter dg = decigram	cm = centimeter cL = centiliter cg = centigram	mm = millim mL = milli mg = millig
Example: 5 kilo	50 hecto	500 deca	5,000 units	50,000 deci	500,000 centi	5,000,00

DIVIDE numbers by 10 if you are getting bigger (same as moving decimal point one space to the left)

MULTIPLY numbers by 10 if you are getting smaller (same as moving decimal point one space to the right)

TOPIC #2 REVIEW PACKET

EARTH'S SHAPE

Earth is **not** a perfect sphere. The actual name for Earth's shape is an *Oblate Spheroid*. That means that its shape is slightly bulged at the equator and flatter at the poles. Earth is only slightly oblate, so our eyes cannot detect its true shape. To us, Earth looks like a perfect sphere.

Diagram 1

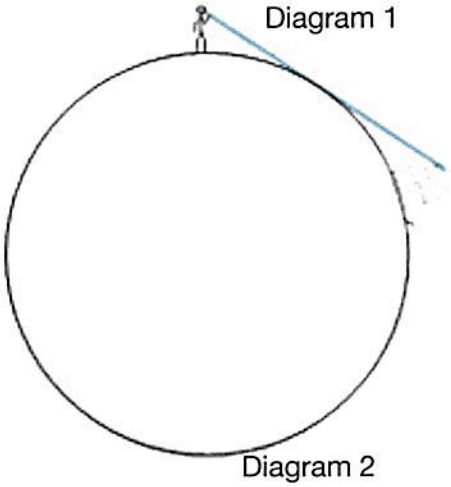


Diagram 2

EVIDENCE THAT PROVES EARTH IS ROUND

1. Pictures/images from space (best evidence)
2. The Mast Effect — As a ship sails towards the horizon, the ship appears to be disappearing from bottom to top. If the Earth were flat, the ship would just appear to get smaller and smaller as it sailed away.
3. Gravity — Gravity gets stronger as you get closer to Earth's core. Since the Earth is an oblate spheroid, we are furthest from the core at the Equator, and closest to the core at the poles. This could be measured by our weight, which is a measure of how much gravity is pushing down on us. As we travel away from the equator (heading towards the north or south poles), our weight will slightly increase because we're getting closer to the core. As we travel closer to the equator, our weight will decrease because we're traveling further away from the core.
4. Lunar Eclipse — Earth's shadow is cast on the moon. The shadow is curved which means Earth must be round.

Diagram 3

MODELS OF EARTH

Good models of Earth are objects that are very smooth and round.
-Ping pong ball
-Marbles
-etc.
To us, Earth doesn't have a very smooth surface. But in space, we cannot see the large mountains because we're so far away. Earth appears to have a smooth, rounded surface.
***Planets are round due to rotation.

Diagram 4

Diagram 5

LINES OF LATITUDE

Aka "parallels"

- Measures the angular distance north or south of the Equator
- These <u>imaginary</u> lines run east to west and divide the earth into a northern and southern hemisphere
- Latitude lines run from 0° to 90° north (north pole) or south (south pole)
- Each degree of latitude is approximately 69 (68.8) miles apart

- ****Lines of latitude NEVER intersect*

<u>Cardinal Direction</u>: North, East, South, West
<u>Profile View</u> — View of an object from the side
<u>Polar View</u> — View of an object from the top

Profile view Polar View

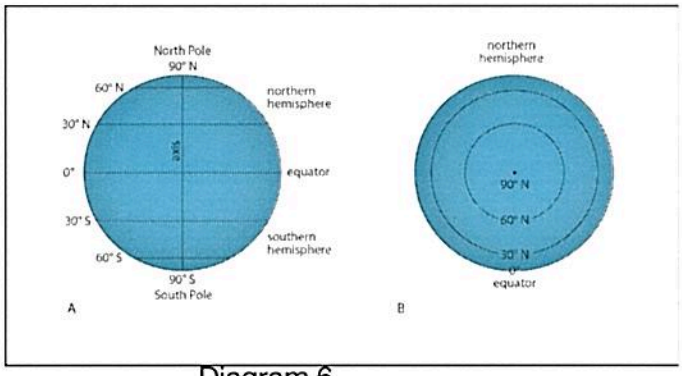


Diagram 6

LINES OF LONGITUDE

Aka "Prime Meridians"

- Lines that run north and south, but divide earth into an eastern and western hemisphere
- The prime meridian (0°) is the reference point for longitude. It runs through Greenwich, England
- Longitude lines are farthest apart at the Equator and converge at the poles
- Longitude ranges from 0° to 180° (International Date Line/IDL)

IMPORTANT DEGREES OF LATITUDE

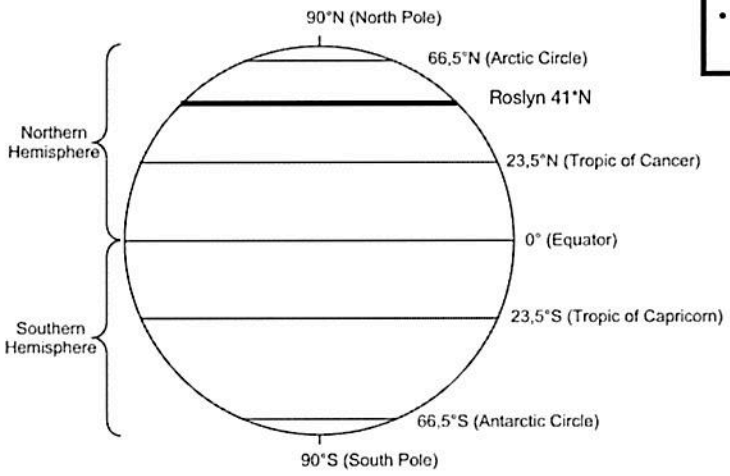


Diagram 7

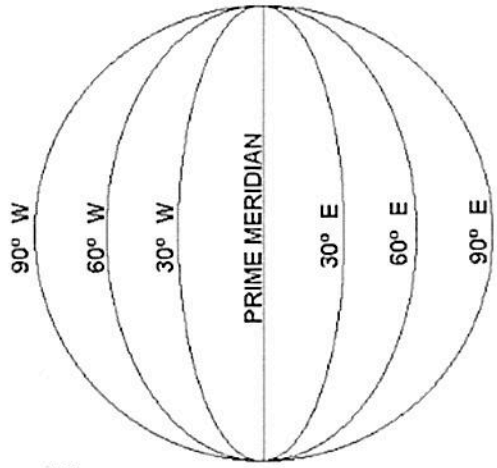
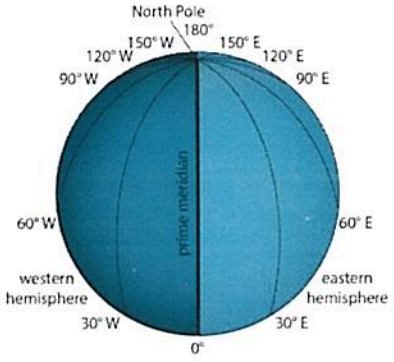


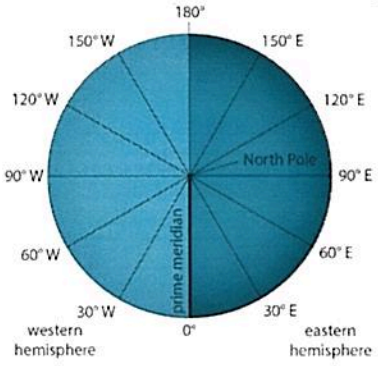
Diagram 8

A



prime meridian view

B



north polar view

Diagram 9

LONGITUDE AND TIME

The Earth rotates 15° per hour (360° divided by 24 hours), so every 15° of longitude represents a different hour of the day.

WEEL — West is Earlier, East is Later (subtract time if location is West of reference, add time if location is East of reference) this is due to Earth rotating counterclockwise.

To find the time of different locations on earth:

1. Find the difference of the longitude lines
2. Divide by 15
3. Add or Subtract that number from the time at your reference line of longitude

Ex) Find what time it is at 60°E when it is 12pm at Greenwich, England (0°)

1. 60° - 0° = 60°
2. 60° ÷ 15 = 4 hours
3. 12pm + 4 hr = 4pm
4. The time at 60°E would be 4pm when it is 12pm at Greenwich, England.

To find the longitude of different locations on earth:

1. Find the difference of hours between the two locations
2. Multiply by 15

Ex) Find what degree of longitude would be at 5am when it is 8am in Greenwich, England

1. 8 - 5 = 3 hrs
2. 3 x 15 = 45
3. It would be 5am at 45°E when it is 8am in Greenwich, England.

TOPOGRAPHY

VOCABULARY

Isolines: Lines that connect points of equal value on a topographic map

- Contour Lines: Lines that connect points of equal elevation
- Isobars: Lines that connect points of equal air pressure
- Isotherms: Lines that connect points of equal temperature
- Isohyets: Lines that connect points of equal rainfall
- Hachured Lines: Lines with dashes that represent a depression on a topographic map

Field: Any region of space that has some measurable value at every point in that region

ex) Gravitational field, magnetic field, etc.

Contour Interval: The number you count by while connecting points of equal value

A topographic map is a map that connects points of either equal elevation, air pressure, temperature, or rainfall. You connect the points based on the contour interval that the directions give you.

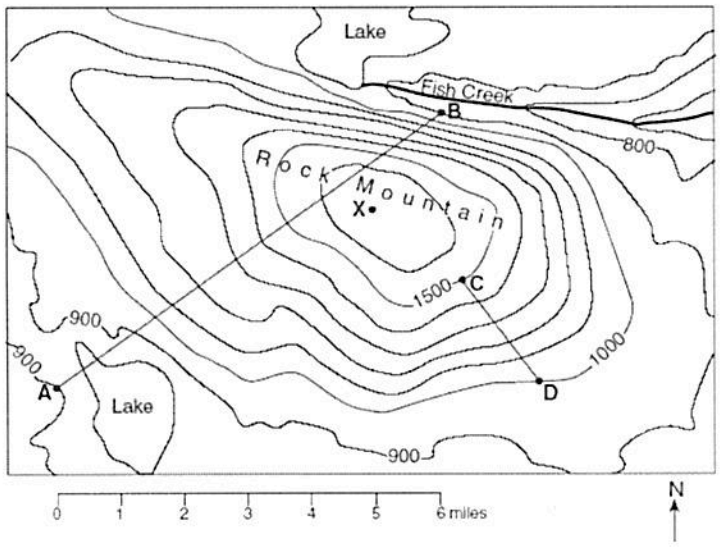


Diagram 10

Creating your own Topographic Map

When creating your own topographic map, you have to connect the DOTS of equal value on your map.
DO NOT TOUCH ANOTHER DOT OF A DIFFERENT VALUE!!!

The V-Rule: Lines bend towards higher elevation when they are being drawn across a stream or river

Using Hachured Lines:
Hachured lines are dashed lines that represent a depression on your map. The first hachured line that you draw should be equal to your previously drawn line.

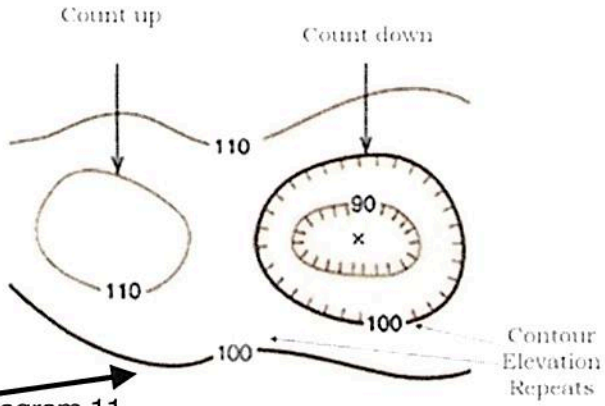


Diagram 11

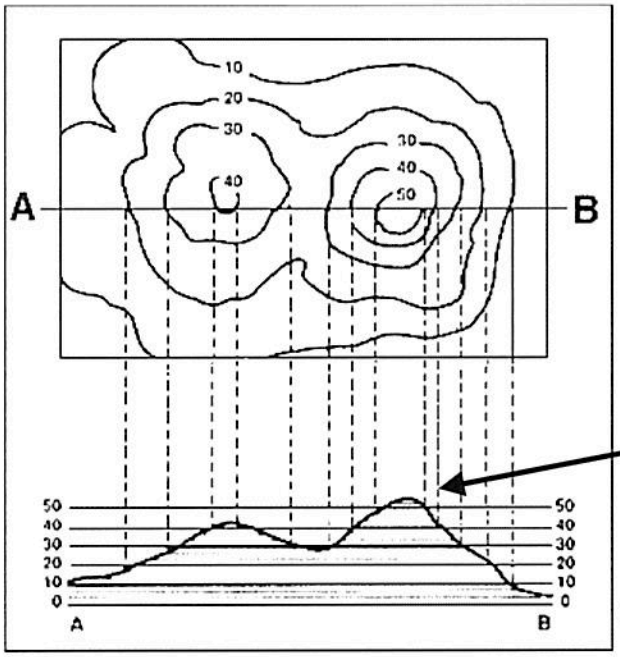


Diagram 12

CONSTRUCTING A PROFILE

A profile is a side view of the mountain. In order to create a profile of your own, you have to:

1. Mark all the contour lines in between the two points you've chosen, with their values, on a scrap piece of paper
2. Transfer that paper to a graph (most of the time, the graph is already made for you)
3. Mark all the different elevations on the graph
   - *You must mark the different elevations with an "x" not a dot!!!*
4. Connect all the points
   - *When connecting your points, if there is a depression, you must continue your line a little further down. If your line curves upwards, you must continue your line slightly above the next line.*

FINDING THE GRADIENT

The gradient is the average slope between two points. The closer together the lines on a map are, the greater the gradient. The further apart the lines are, the smaller the gradient. To find the gradient, you must use a formula.

$$Gradient = \frac{\Delta\, value}{distance}$$

You don't need to memorize this formula, though. It's on the first page of your reference tables.

CALCULATING THE GRADIENT

To receive full credit on the regents, you have to follow these steps:

1. Write out the formula
2. Write the formula with the substituted values in the correct spot
3. Solve
4. Write the solution with the correct units.

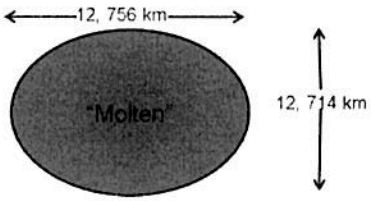
Earth Science Project #2

Earth's Shape

Models- a representation of something, typically on a smaller scale

A. Maps
B. Globes drawings
C. Diagrams
D. Drawing
E. Graphs
F. Formulas

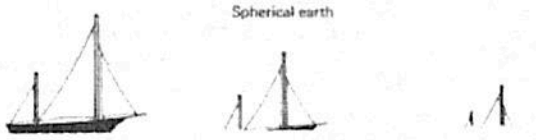
Oblate Spheroid- is the shape of the Earth



A. It is flattened at the poles and bulges at the equator
B. But from outer-space it looks round

Evidence that Proves Earth is Round:

A. Photos from space prove earth is round.
B. Ships that sail towards the horizon disappears behind it.
C. Observations of the lunar eclipses show that earth is round because the shadow is round
D. The pull of gravity gets stronger as you get closer to the center which pulls down and flattens the poles and creates a bulge at the equator.
E. As an observer moves North or South in the Northern Hemisphere the altitude of Polaris also changes.

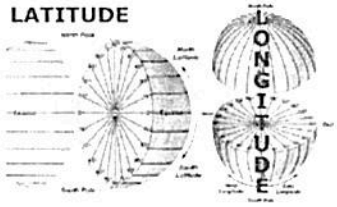


Altitude- the apparent height of a celestial object above the horizon measured as an angle.

Latitude and Longitude

Latitude- Angular distance North or South of the equator.

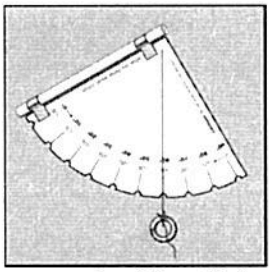
A. They go East to West and measure North to South
B. The Maximum latitude is 90°
C. The important degrees of latitude are:



The sun will never be directly overhead outside of the tropics

1. 0°(equator)-divides the Northern and Southern Hemisphere, it is widest at the equator, and the sun is directly overhead on the equinoxes
2. 23.5°N(Tropic of Cancer)- On the Summer solstice the Sun is directly overhead.
3. 23.5°S(Tropic of Capricorn)-On the Winter solstice the Sun is directly overhead
4. 66.5°N(The Arctic Circle)-On December 21 there is 24 hours of darkness and 24 hours of sunlight on June 21 within the circle.
5. 66.5°S(The Antarctic Circle)- On December 21 there is 24 hours of sunlight and 24 hours of darkness on June 21 within the circle.
6. 90°N(North Pole)-The farthest North you can go
7. 90°S(South Pole)-The farthest South you can go

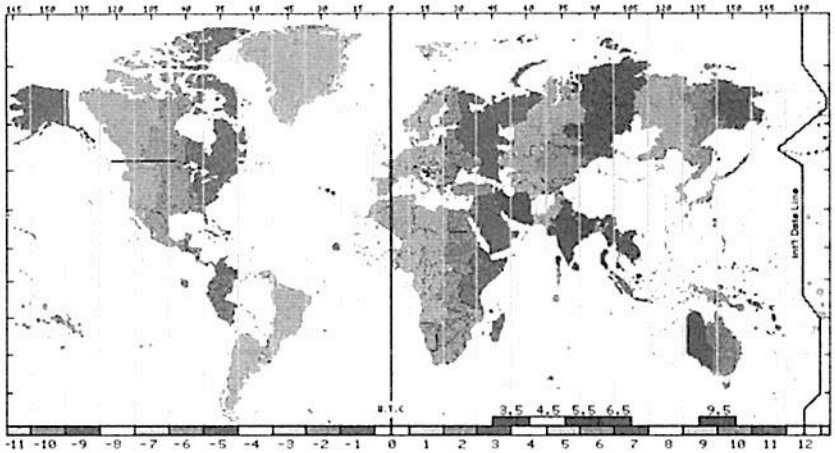
D. Astrolabe- An instrument used to find the altitudes of celestial bodies and finding latitude.



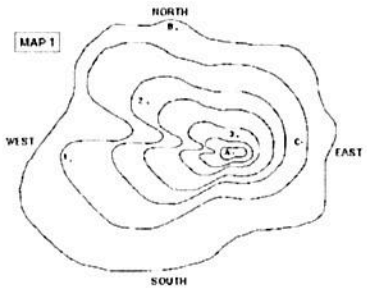
Longitude- Angular distance east or west of the Prime Meridian (0°)

$$\frac{360°}{24\ hrs}=\frac{15°}{hr}$$

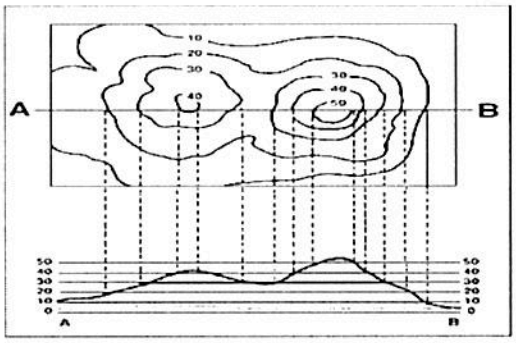
A. They go North to South and measure East to West
B. Maximum longitude is 180°(International Date Line)
C. Every 15° of longitude is equal to an hour
    1. As you move west (left) time becomes earlier, as you move east(right) time becomes later. WEEL (west earlier east later).
    2. Earth take 24 to rotate on its axis so there are 24 time zones.



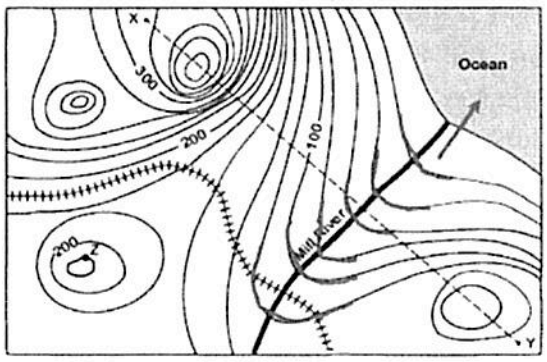
Topographic Maps-show elevation of the land by using contour lines



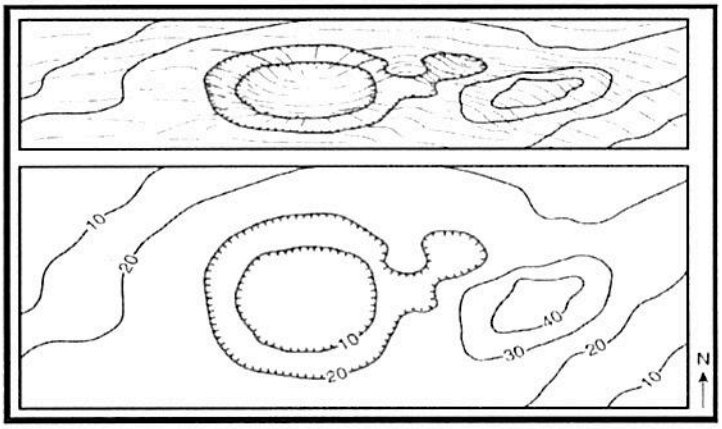
A. Isoline- a line that connects points of equal point of value.
    1. Isotherm- a line that connects point of equal temperature
    2. Isobar- a line that connects point of equal air pressure
    3. Contour line- a line that connects points of equal elevation.
    4. Isohyets- a line that connects points of equal precipitation
B. The rules for isolines are:
    1. They never cross
    2. They can run-off a map
    3. They can never end
C. Gradient-The rate at which field values change from point to point in a field
    1. When the contour lines are closer together the gradient is steeper and when they are father apart the contour lines are farther apart.
    2. The formula is Gradient= change in value/distance
D. Profiles- an exaggerated side view of a portion of the earth's surface along a line between two points.



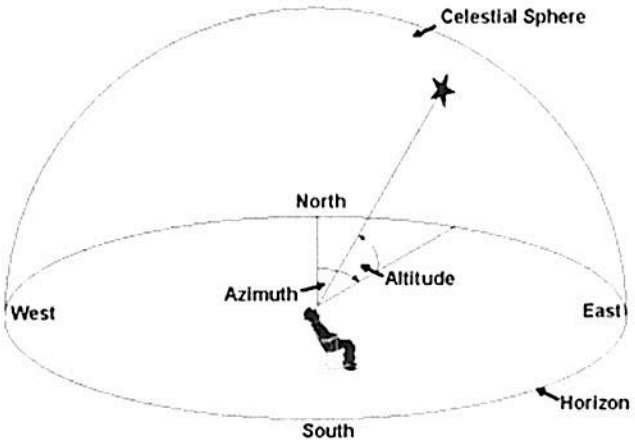
E. Rule of V's- contour lines bend upstream and streams flow from higher elevation to lower elevation so the stream flows in the opposite direction of the contour line.



F. Hachured lines- special contour lines that have hachured marks on the inside to represent a depression.

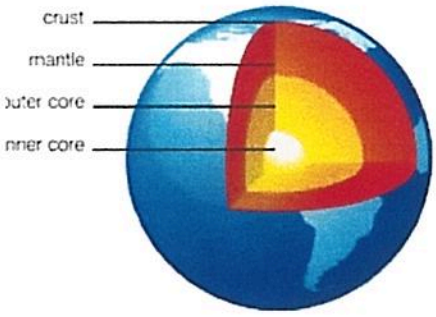


G. Contour interval- difference between 2 adjacent contour lines.
H. Map scale-Map scale is the ratio between distance on a map and the corresponding distance on the ground.
I. Azimuth- The direction of a celestial object, measured clock wise around the observer's horizon from North.



Topography Study Guide

Model – A representation of a particular object or scenario in the world.



For example, this is a model, or a representation of the earth's interior.

Diagram 1

Oblate Spheroid- This is the shape of earth. It represents the fact that earth is not perfectly round and bulges slightly at the equator.

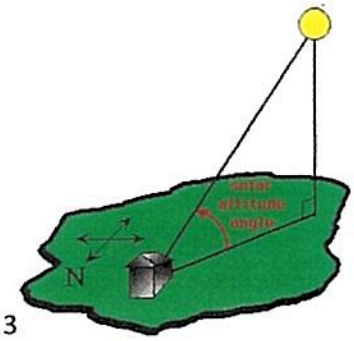
On the left, this photo shows what earth appears to look like. On the right, it shows an exaggerated picture of what earths actual shape is, an oblate spheroid.

Diagram 2

How do we know that the Earth is round?

- Photos taken from space.
- When we observe sailing ships, they appear to disappear along the horizon.

ltitude- The height of a celestial object above the horizon measured as an angle.



This Diagram is showing the suns altitude relative to the house, which is 90 degrees.

iagram 3

atitude- The distance north or south of the equator, which helps to locate positions on earth.

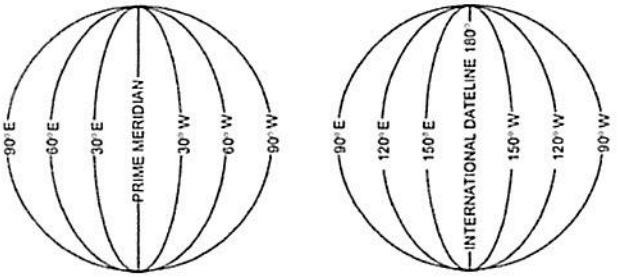
This photo shows the latitude lines on earth.

iagram 4

The important degrees of latitude are

- The Arctic Circle which is located at 66.5 degrees north
- The Antarctic Circle which is located at 66.5 degrees south.
- The Equator which is located at 0 degrees
- The Tropic of Cancer which is located at 23.5 degrees north
- The Tropic of Capricorn which is located at 23.5 degrees south

.ongitude- The distance east or west of the prime meridian. This helps to locate points on earth's surface.



This image is showing the prime meridian, the longitude lines on earth, and the International Date Line, which is 180 degrees.

)iagram 5

\strolabe- A scientific device used for making observations about the sky. This can also help to locate the direction ınd altitude of celestial objects.

.ongitude and Time- The time of day at a certain point on earth is based on your longitude and every 15 degrees. ;o, as you move to the east 15 degrees it is 1 hour later. As you move 15 degrees to the west it is 1 hour earlier.

*N*est- time is earlier

:ast- time is later

***N*EEL-** This is a trick to help you determine if time is increasing or decreasing as you move to different longitude ocations on earth's surface. The letters stand for West-earlier, East-later. This means that as you move toward *N*est time gets earlier and as you move toward the east time gets later.

Topographic Map Rules-

- Contour lines never cross each other because each is representing a different value and one-point can't have more than one value.
- The closer the contour lines, the steeper the slope of the hill.
- Circles in contour lines represent a hilltop or a depression.

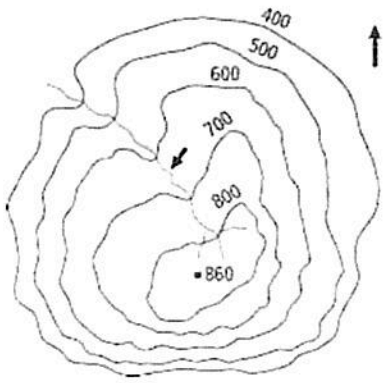


Diagram 6

olines- Lines on a map connecting points of equal value (such as elevation or temperature).

obar- A line on a map connecting equal points of barometric pressure.

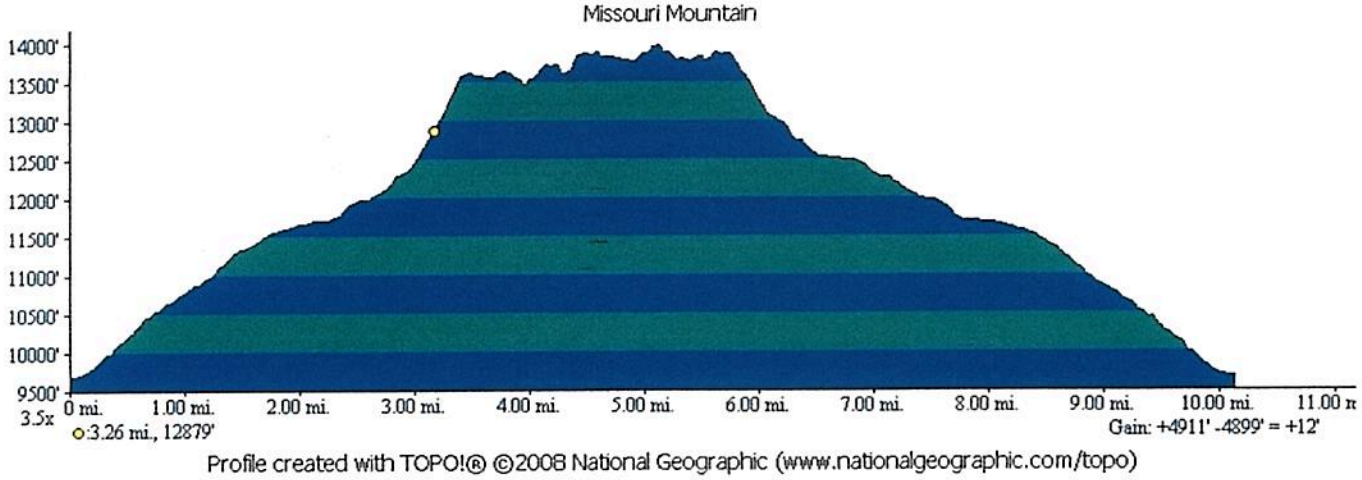
ontour Line- A line on a map connecting equal points of elevation of a surface.

ohyets- A line on a map connecting equal points of precipitation on a surface.

otherm- A line on a map connecting points of equal temperatures.

radient- The change in a certain variable, such as elevation or temperature, over a certain distance. The formula sed to find this is change in field value/ distance. For example, 10,000 ft is the change in field value (elevation) nd the distance is 5 miles. This means the gradient would be 2000 ft/mi.

rofile- A side view of a mountain showing elevation and shape of that mountain.



iagram 7

'- Rules- When looking at a contour map, as contour lines cross over a river they bend and form a form a V shape ıcing upstream. This allows you to determine what direction the river is flowing.

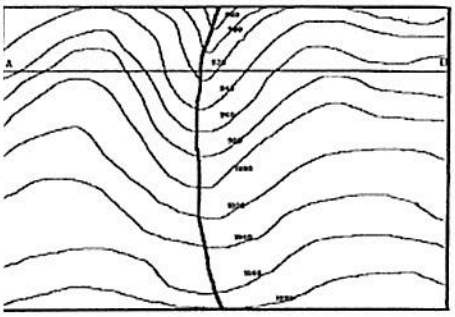


Diagram 8

As you could see, on this map the contour lines are bending toward the south, so we know the river is flowing north.

lachured Lines- Small lines drawn perpendicular to the circles of contour lines to indicate that there is a epression at that location and that it is not a hilltop.

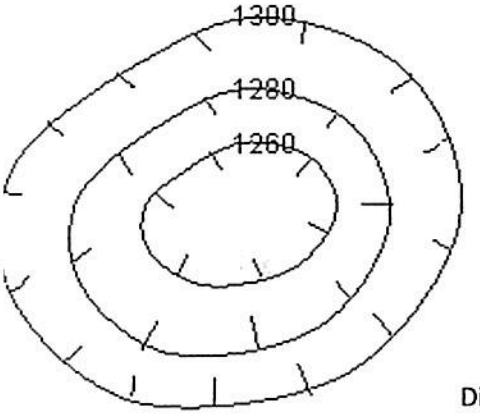


Diagram 9

ardinal Direction- A principal compass that has four directions, North, South, East and West.

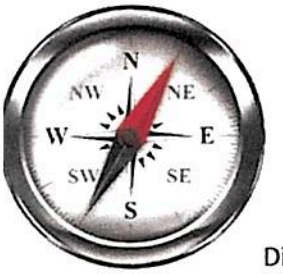


Diagram 10

ızimuth- A measurement increasing clockwise from 0 degrees (due north) to 360 degrees. It is the exact angle long the horizon which gives more precise measures than just saying North, East, South or West.

Map Scale- The ratio between the distance on a map and the distance in real life.

Contour Interval- The distance between values of contour lines on a topographical map.

Study Chart: Moon

Our Moon was formed 4.6 billion years ago about 30 to 50 million years after the formation of the solar system. The Moon is a natural satellite to Earth, meaning it is a celestial body that orbits around a larger body.

Diagram 1: Moon's Landscape

Formation of the Moon

Giant Impact Theory- a rogue planet (bigger than Mars) collided into Earth. Little pieces of earth broke off and clumped together, forming the Moon.

Similar to Earth, the moon has a crust, mantle, and core. In the interior, the moon has a solid iron core surrounded by an outer core made of molten liquid iron. The crust is mostly made of oxygen, silicon, magnesium, iron, calcium, and aluminum. The Moon is very dense, with a density of 3.3 g/cm^3.

Lunar Landscape

The Moon's landscape mostly consists of craters, which form when there is an impact of meteoroids.

Q: Why does the Moon have an abundance of craters?

A: The Moon has no atmosphere, and little to no liquid water.

Moon Phases

Moon phases occur because of the Moon's revolution around Earth. During each phase in a cycle, we see a different sunlit portion of the Moon. It takes 27.3 days for the Moon to revolve around the Earth, but there are 29.5 days in a complete cycle of moon phases. This is because the Moon is revolving at a rate of one degree per day, therefore the Moon needs two days to "catch up" to Earth.

Additional Moon Phase Terms

Blue Moon- the appearance of an additional full moon in one month.

Waxing- the period of time that starts at a New Moon when the Moon appears to grow in size from a New Moon to a Full Moon. The right side of the Moon is illuminated.

Waning- the period of time that starts at a Full Moon when the Moon appears to shrink in size from a Full Moon to a New Moon. The left side of the Moon is illuminated.

Q: Why do we always see the same side of the Moon?

A: The Moon's period of revolution and rotation are same. This is known as a synchronous rotation.

Diagram 2: Waxing and Waning Phases

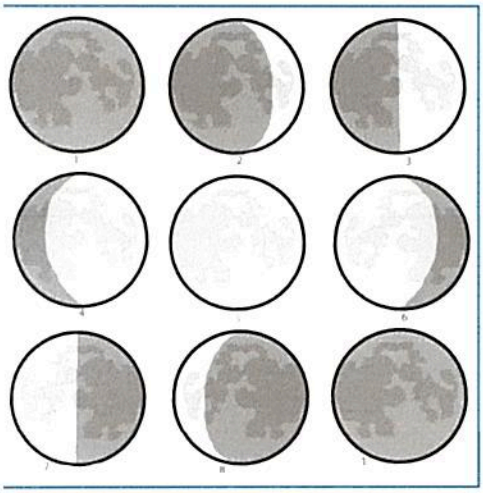


Diagram 3: The Moon Phases

The Eight Moon Phases

New Moon
Waxing Crescent
First Quarter
Waxing Gibbous
Full Moon
Waning Gibbous
Third Quarter
Waning Crescent

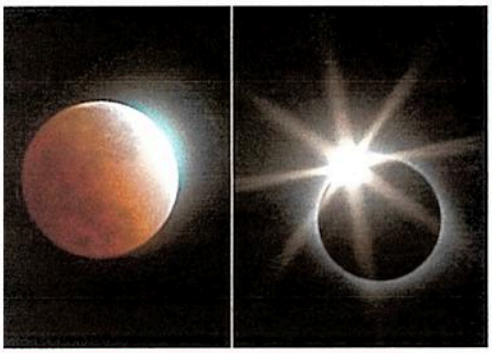


Diagram 4: A Solar and Lunar Eclipse

Eclipses

Eclipse- astronomical event occurring when a celestial object moves into the shadow of another, partially or fully obscuring it from view.

Solar Eclipse
Solar Eclipses occur when a New Moon travels between the Sun and Earth. The Moon's shadow falls onto Earth, and a solar eclipse generally gives an appearance of a ring of light in a darkened sky.

Lunar Eclipse
Lunar Eclipses occur when a Full Moon passes into Earth's shadow. During a total lunar eclipse, the Moon appears copper.

Totality- when the Moon entirely blocks the Sun or when the Moon is entirely in the Earth's shadow.

Partial Eclipse- when the moon is not directly between the sun and the Earth or the Moon is not completely in Earth's shadow. During a partial solar eclipse, the sun's light is not entirely blocked, so it doesn't get as dark outside as it would during a total solar eclipse.

Annular Eclipse- when the Moon is covering the Sun's center, which leaves the Sun's visible outer edges to form a ring shape, or annulus around the Moon.

Umbra- the inner region of a shadow on the Earth or Moon that experiences a total eclipse.

Penumbra- the outer region of a shadow on the Earth or Moon that experiences a partial eclipse.

Q: Why don't eclipses happen every New/Full Moon?

A: The Moon's orbit is tilted compared to Earth's orbit.

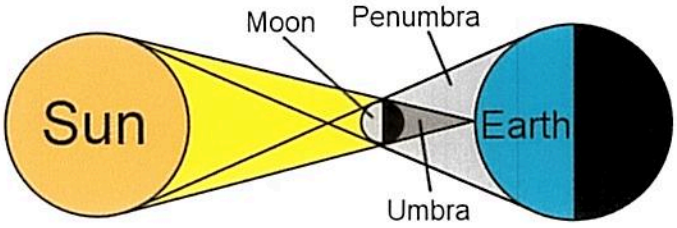


Diagram 5: A Solar Eclipse Showing the Umbra and Penumbra

Tides

Tides are the periodic rising and falling in sea level with respect to the land. They are produced by gravitational attraction of the Moon and the Sun. The Moon plays a larger part in the Earth's tides because it is so close to the Earth. There are two high tides and two low tides every 24 hours.

Tidal bulge- when the gravitational attraction of the Moon causes oceans to bulge out in the direction of the Moon. Another bulge also occurs on the opposite side because the Earth is being pulled toward the Moon.

Spring Tide
Spring Tides are tides that occur every New and Full Moon. This is when the Moon, Sun and Earth are all aligned. Spring Tides cause higher high tides and lower low tides. This creates a large tidal range.

Neap Tide
Neap Tides occur at First and Last Quarter phases. This is when the Sun, Moon, and Earth are at a right angle to one another. Neap Tides cause lower high tides and higher low tides. This creates a small tidal range.

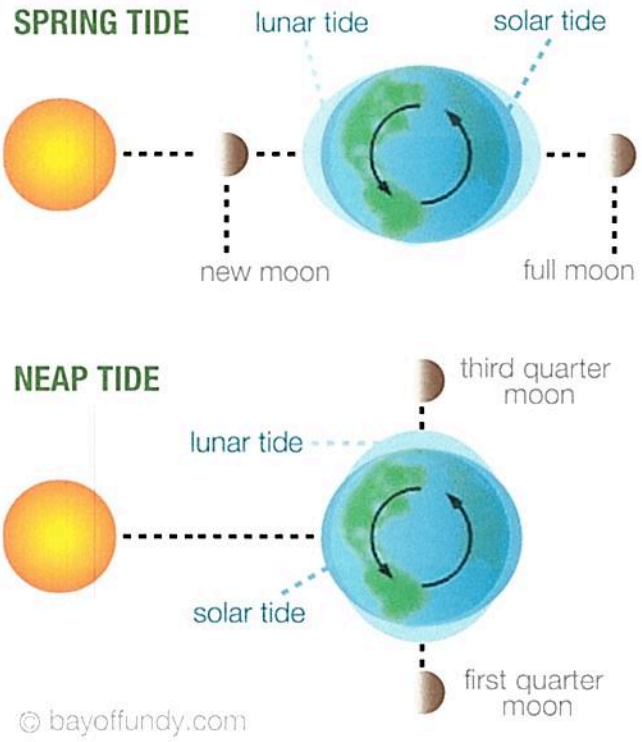


Diagram 6: Spring and Neap Tides

Moon's Orbit

Sidereal Month- the time needed for the Moon to return to the same place against the background of the stars, about 27 days and 7 hours.

Synodic Month- the time it takes for the Moon to complete cycle of phases of the Moon as seen from Earth, about 29.5 days.

Geosynchronous Orbit- a high Earth orbit that allows satellites to match Earth's rotation. It is located above the Earth's equator.

Perigee- the point in the orbit of the Moon that it is closest to Earth.

Apogee- the point in the orbit of the Moon that it is farthest from Earth.

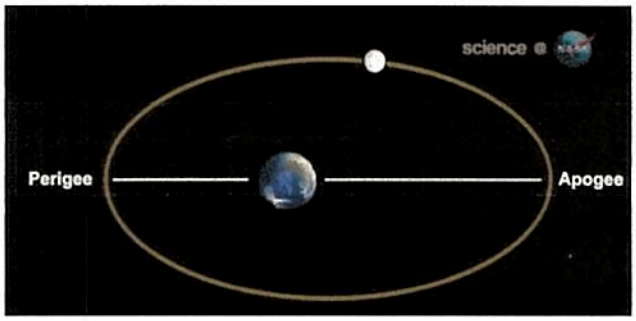


Diagram 7: The Moon's Orbit

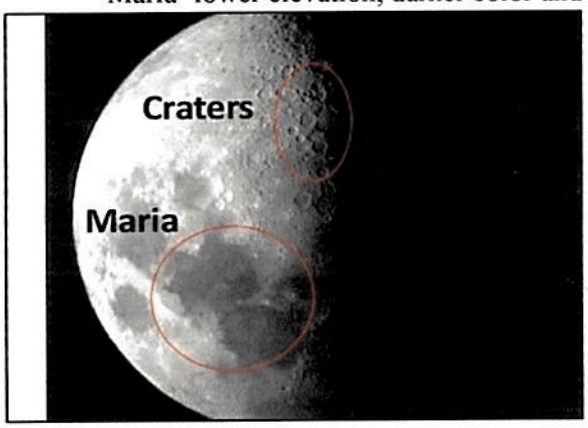
Moon Study Project

Formation of the moon

-Impact theory- formed by an impact
-Sister Theory- earth and the moon were created at the same time
-Daughter Theory- earth created the moon
-Captured Theory- captured by earth and was then forced to orbit around it

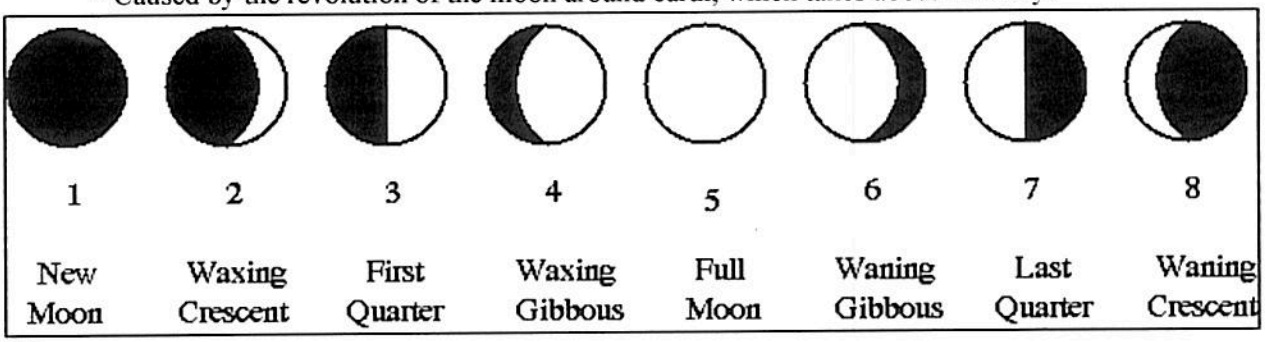
Lunar landscape

-Craters- higher elevation and brighter color than Maria and resemble mountains
-Maria- lower elevation, darker color and flatter landscape than craters



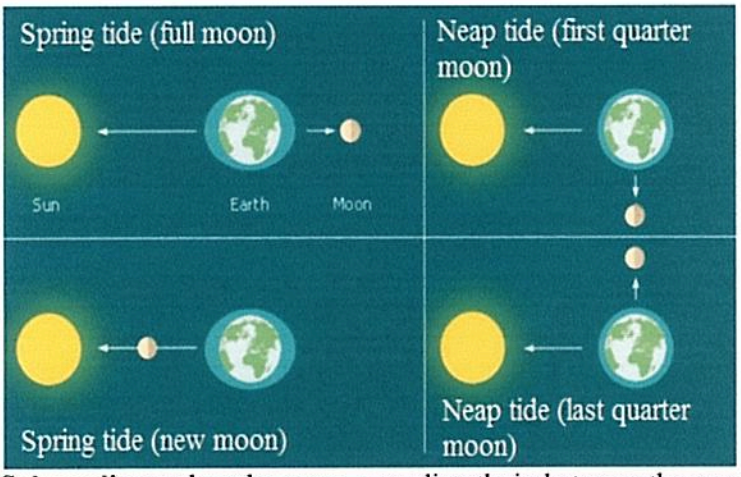
Moon phases

- Caused by the revolution of the moon around earth, which takes about 29.5 days

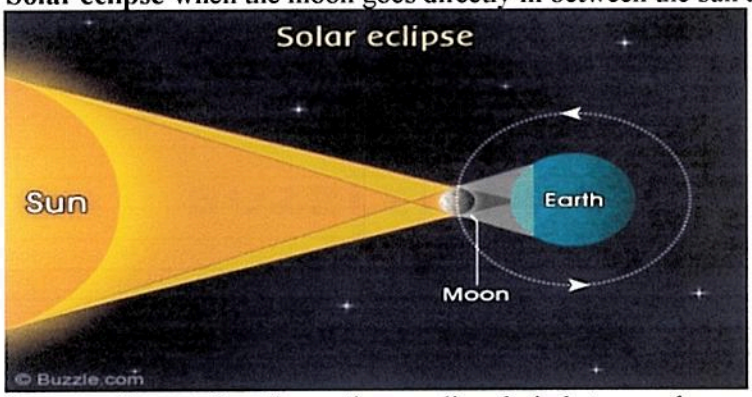


Tides

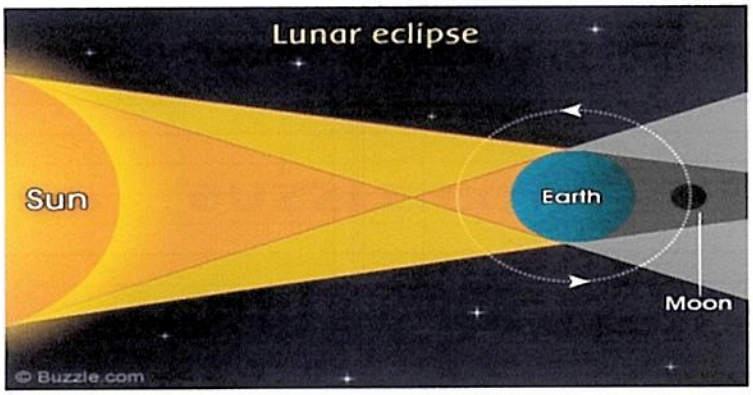
-The moon's pull has great influence on earth's tides
  -The moon pulls on a specific part of the ocean, causing it to rise and fall (high tide)
    -this also happens on the other side of the planet, exactly opposite of where the moon is pulling on
    -the sun has a smaller influence on earth's tides than the moon since its farther away
-Diurnal Tides: normal tides that occur twice each day
-Neap Tides: occur only during first and third quarter, tides are strongest closest to and farthest away from the moon, weaker tides are found closest to and farthest away from the sun, smaller difference in size between smallest and largest waves
-Spring Tides: occur only during new and full moons, tides are strongest when closer to and farther away from the moon and sun but are weakest when in between those points, larger difference in size between smallest and largest waves



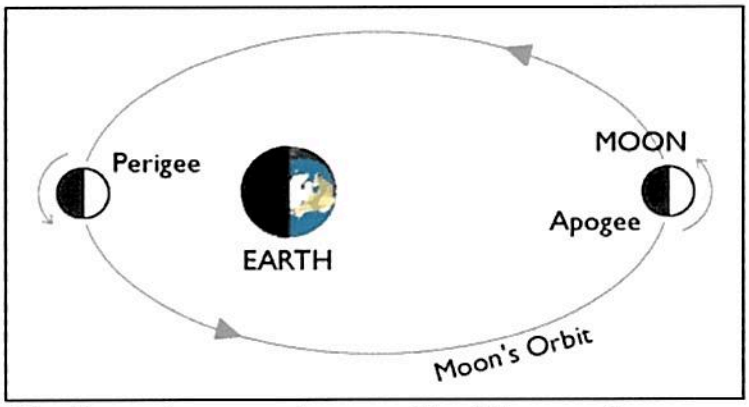
Solar eclipse-when the moon goes directly in between the sun and the moon



Lunar eclipse- when the earth goes directly in between the sun and the moon



Totality- when an area experiences complete darkness during an eclipse
Partial Eclipse-when an area only experiences partial darkness during an eclipse
Blue moon- the second full moon in a month
Perigee- where the moon is closest to the earth in its orbit
Apogee- where the moon is farthest away from earth in its orbit



Why do we always see the same side of the moon?

–the amount of time it takes for the moon to revolve once is equal to the amount of time it takes to rotate once

Why don't eclipses happen every new/full moon?

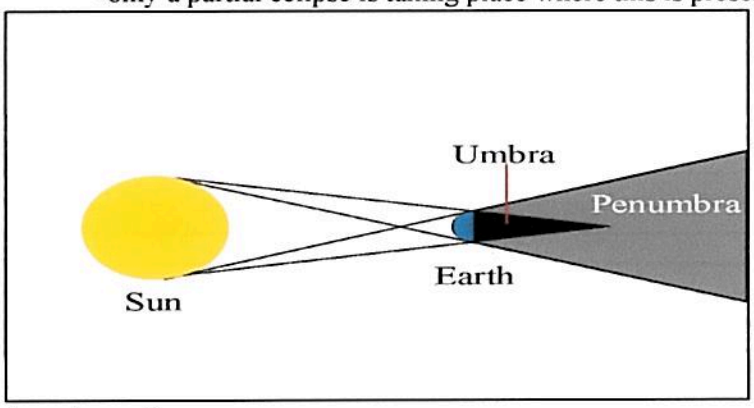
– the moon's orbital plane is tilted in comparison to earth's orbital plane

Umbra

- the darker section of a shadow in a solar eclipse
-a total eclipse is taking place where this is present

Penumbra

-the lighter section of a shadow cast by a solar eclipse
-only a partial eclipse is taking place where this is present



Annular eclipse

- a solar eclipse where the edge of the sun is still visible

Sidereal month
- how long it takes the moon to revolve once around the earth

Synodic month
- how long it takes for the moon to rotate once

Waxing
- to become brighter

Waning
- to become less bright

Geosynchronous Orbit
- an orbit where the duration of revolution and the duration of rotation are equal
- this creates a 'near side' and a 'far side' of the moon

Text Citations: in MLA style

"Annular Eclipse: Ring of Fire over Africa." *Astronomy Now*, astronomynow.com/2016/09/01/annular-eclipse-ring-of-fire-of-africa/.

"The Differences Between Lunar and Solar Eclipses You Never Noticed." *UniverSavvy*, UniverSavvy, universavvy.com/difference-between-lunar-solar-eclipses.

Lecture 9: Eclipses of the Sun & Moon, www.astronomy.ohio-state.edu/~pogge/Ast161/Unit2/eclipses.html.

Diagram/Picture Citations:

Diagram 1: Craters and Maria
https://www.slideshare.net/MMoiraWhitehouse/characteristic-s-of-the-moonteachpptx
Diagram 2: Moon Phases
www.drstandley.com/astrologycharts_2017_Moon_Phases.shtml
Diagram 3: Spring and Neap Tides
https://socratic.org/questions/what-is-a-neap-tide
Diagram 4: Solar Eclipse
https://universavvy.com/difference-between-lunar-solar-eclipses
Diagram 5: Lunar Eclipse
https://universavvy.com/difference-between-lunar-solar-eclipses
Diagram 6: Perigee and Apogee
https://sites.google.com/a/ladueschools.net/apogee/
Diagram 7: Umbra and Penumbra
www.astronomy.ohio-state.edu/~pogge/Ast161/Unit2/eclipses.html
Diagram 8: Annular Eclipse

Earth Science Honors Project Topic #4

Formation of our solar system:

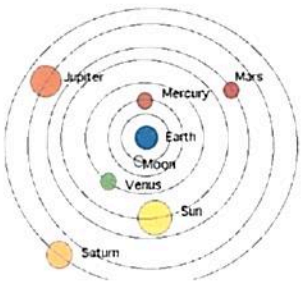
- Our solar system formed about 4.6 billion years ago.
- It was formed by orbiting dust coming together and growing larger to form planitesimals
- Planitesimals are chunks of huge rock that can have their own gravitational field because they are so big.
- When planitesimals collide they make planets.
- These planets are held together by gravity from the sun.
- Our solar system is made up of the sun, moons, planets, comets, meteoroids, asteroids, dwarf planets, and other objects held nearby by gravity.
- The sun is the only star in our solar system and it is the center (primary)
- The terrestrial planets are more rocky and Earth-like. They are smaller, denser, and have few or no moons. These planets are Mercury, Venus, Earth, and Mars.
- The Jovian planets are more gaseous. They are bigger, less dense, and ringed. These planets are Jupiter, Saturn, Uranus, and Neptune, and they are known as the "gas giants."

Ptolemy:

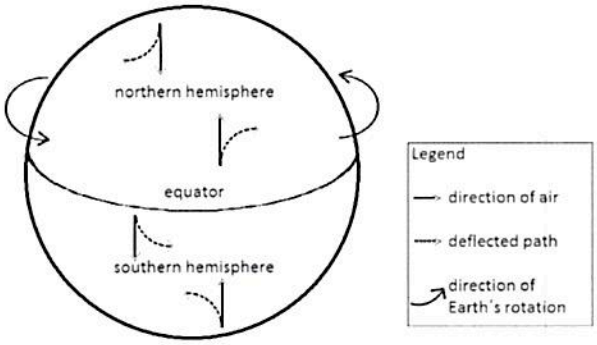
- Ptolemy created the geocentric model of the solar system.
- This model was incorrect.

The geocentric model:

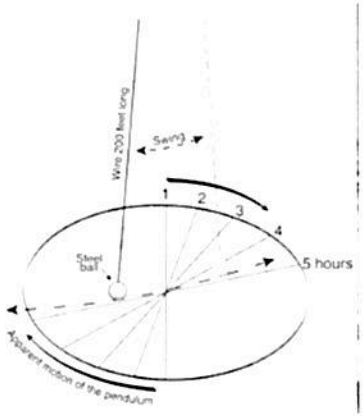
- In Greek, "geo" means earth, and "centron" means center.
- Stated that the Earth was stationary and was the center of our solar system, and all celestial objects, including the sun revolved around Earth.
- This model stated that when all celestial objects orbit the Earth, they do so in perfectly spherical orbits.
- This model also stated that the earth was perfectly spherical and was not flat.
- The geocentric model seemed reasonable because it explained why celestial objects, including the sun, moon, and stars moved.



- However, this model was not correct because it could not explain earth's rotation, which is shown in the Coriolis Effect and Foucault's Pendulum.
- The Coriolis Effect was proof to show that the earth rotates on its axis. As where in the geocentric model, the earth was stationary and did not rotate.
    - In the Coriolis Effect, fluids and projectiles (such as winds and ocean currents) appear to be curved in a certain direction, and this is caused by earth's rotation.
        - In the Northern Hemisphere, the paths are curved to the right.
        - In the Southern Hemisphere, the paths are curved to the left.

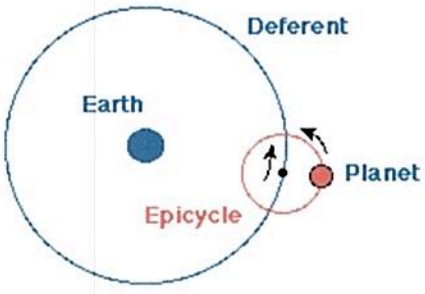


    - The Foucault Pendulum provides evidence that earth rotates because the path of a freely swinging pendulum appears to change over a period of time in a predictable manner. The pendulum does not change direction, but the earth rotates underneath it, which causes it to appear to change direction.



Epicycles:

- Was Ptolemy's explanation on how sometimes some planets appeared to be moving backwards.
- **Epicycles** are small circles that planets were believed to be traveling in as they orbited the earth.
- They created a very complex model of the solar system.

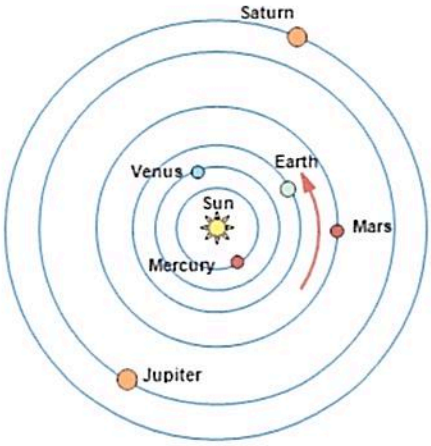


Copernicus:

- Copernicus created the heliocentric model of the solar system.

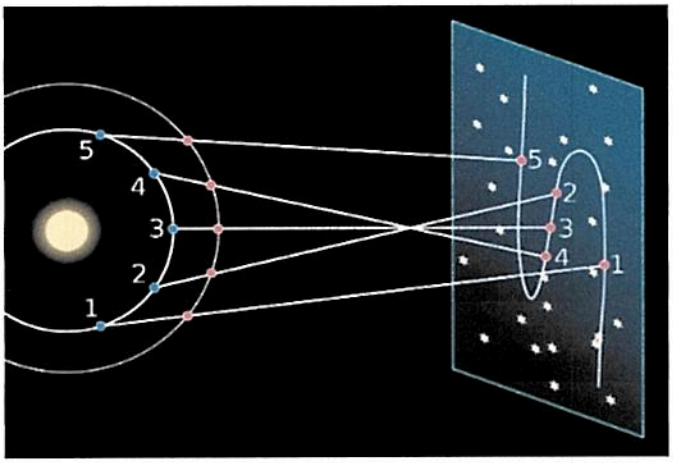
The heliocentric model:

- This model featured the Sun as the center of the solar system.
- All other celestial objects, including the Earth, orbited around the Sun in this model.
- This model was correct because it explained the Coriolis effect and Foucault's pendulum because the earth is rotating in these examples.
- This model was accurate and simple, and it was able to explain retrograde motion.



Retrograde motion:

- This is when sometimes some planets appear to be moving backwards. This appearance is caused by faster planets passing slower planets in their orbits.

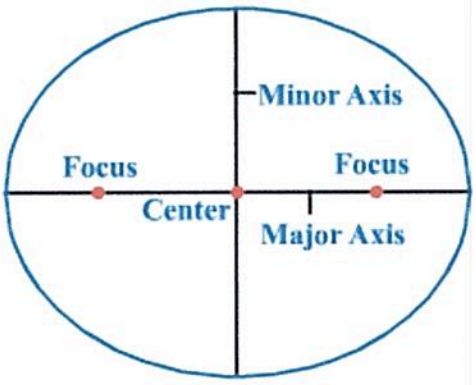


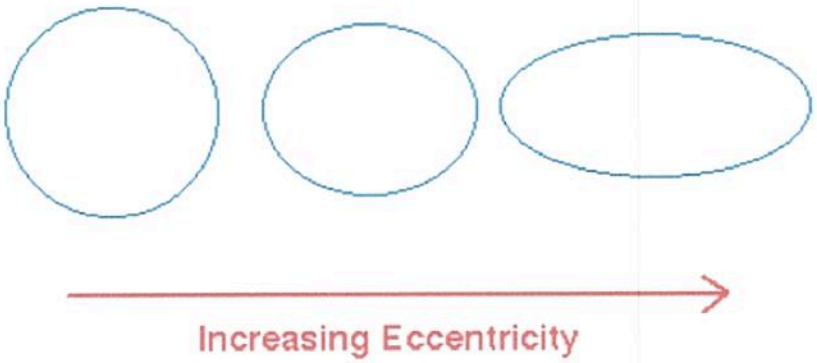
Johann Kepler:

- Created three laws of planetary motion to prove that the heliocentric model of the solar system was correct and the geocentric model was incorrect.

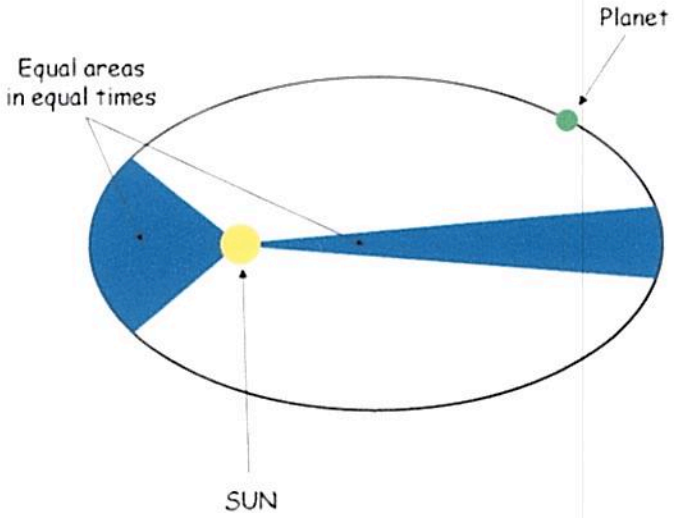
Kepler's 3 laws of planetary motion:

- **1st law:**
  - All planets orbit the sun in elliptical orbits, not perfectly spherical orbits.
  - An **ellipse** is an oval or circle that is flattened.
  - **Eccentricity** is a measure of how elliptical, or ovular a planet's orbit around the Sun is.
    - The formula for eccentricity is: eccentricity = $\frac{\text{distance between foci}}{\text{Length of major axis}}$
  - **Foci** are the points equally separated in a planet's orbit. The sun is always one of the focal points. The other focal point is an imaginary point in space.
  - The maximum eccentricity is 1.000 (a straight line) and the minimum eccentricity is 0.000 (a perfect circle)
  - The major axis of an ellipse is the longest diameter of an ellipse that goes from side to side horizontally.
  - The minor axis is the shortest diameter of an ellipse that goes from top to bottom vertically.



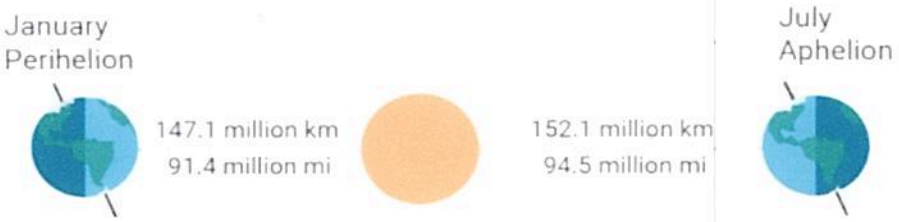


- **2nd law:**
  - If you draw an imaginary line from the Earth to the Sun, that line will travel equal areas in the same amount of time. This is caused by the planet traveling different speeds throughout its orbit. The planet's orbital velocity is slower when it is farther from the Sun, and its orbital velocity is greater when it is closer to the Sun.
  - **Orbital velocity** is the speed at which a planet is traveling as it orbits the Sun.



  - Earth has a slightly eccentric orbit, which causes the distance from the Sun to change throughout the year.
  - **Perihelion** is when the Earth is closest to the Sun, and this is on January 3rd. During Perihelion, the Earth has:
    - Maximum orbital velocity.
    - Maximum gravitational attraction to the Sun.
    - Maximum kinetic energy.
    - The apparent diameter of the Sun is also at a maximum.
    - The potential energy of the Earth is at a minimum.

- **Aphelion** is when the Earth is farthest from the sun, and this is on July 4th. During Aphelion, the Earth has:
    - Minimum orbital velocity.
    - Minimum gravitational attraction to the Sun.
    - Minimum Kinetic energy.
    - The apparent diameter of the Sun is also at a minimum.
    - The potential energy of the Earth is at a maximum.



- Since the Earth is at different distances from the sun throughout the year, the size of the Sun appears to change. This is called the **apparent diameter**.
    - During Perihelion, the apparent diameter of the Sun appears to be greatest because the Earth is closest to the Sun at that point.
    - During Aphelion, the apparent diameter of the Sun appears to be smallest because Earth is farthest from the Sun at that point.

- **3rd law:**
    - Planets that are closest to the sun have a greater orbital velocity (greater speed) than planets that are farther from the sun. This is because the planets have to travel a smaller distance around the sun each year if they are closer.
    - This was able to be mathematically proven by Johann Kepler.

Galaxies:

- There are billions of galaxies in the universe.
- Galaxies are made up of stars, planets, and many other celestial objects all held together by gravity.
- There are three different types of galaxies:

Spiral Galaxies	Elliptical Galaxies	Irregular Galaxies
Have three basic parts: A nuclear bulge: - Also known as the galactic center - This is located at the center of the galaxy. - It is believed to have a black hole. - This part has the oldest stars. A disk: - This is made up of gas, dust, and many younger stars. - The disk makes the spiral arms. A halo: - This is part of the disk and it is a spherical area around the bulge - It contains older groups of stars called globular stars.	- Have an elliptical and ovular shape. - The stars in these galaxies are very old. - No new stars form here. - Little dust and gas are left between these stars. - There are no hot, bright, or massive stars found in elliptical galaxies.	- Make up less than 3% of galaxies in the universe. - There is no symmetry in these galaxies. - These galaxies mostly form from collision or near misses of different galaxies.

Milky Way Galaxy:

- The Milky Way Galaxy is a spiral galaxy and it contains billions of stars and other celestial objects.
- Our solar system is located in this galaxy and it is only a very small part of it.
- Our Sun is located 2/3 of the way out of the center on the Orion arm.
- The Milky Way galaxy is part of a local cluster of galaxies.

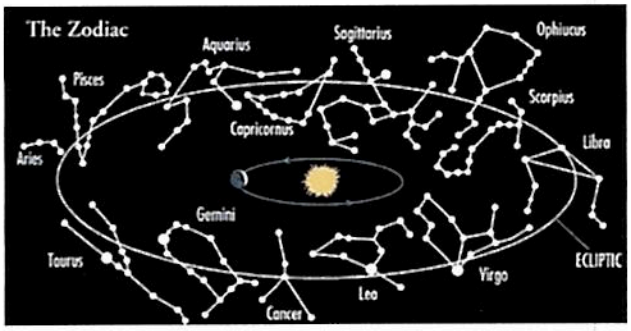
Impact Crater:

- An impact crater is when a meteorite or any object crashes into a planet or moon and creates a huge dent in the planet or moon, most times circular with a raised rim.

- The moon has many more craters on its surface than the Earth because it has little to no atmosphere to protect itself.

Seasonal Constellations:

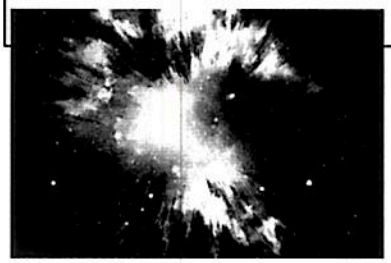
- Seasonal Constellations are caused by Earth's revolution around the Sun.
- Different constellations are visible throughout the year because the Earth is in a different spot in its revolution, while the constellations are stationary.



Formation of the Solar System (Two Main Theories)

Theory One - Steady State: This theory states that the universe formed from existing matter and has slowly grown over time steadily, hence that name steady state.

Theory Two – Big-Bang: This theory states that all matter and everything in the universe formed in the first few seconds after a cosmic explosion (expansion)

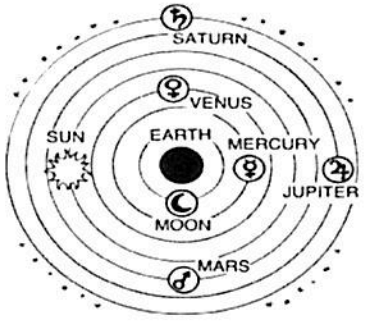


Ptolemy

Ptolemy was Greco Roman astronomer, mathematician, astrologer, and geographer. He was well known for proposing the geocentric model to the solar system.

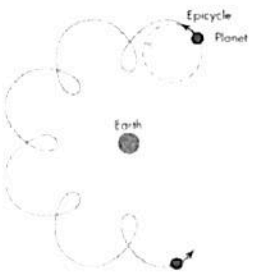
Geocentric

The geocentric model of our solar system is based off the idea that Earth is at the center of the universe and everything revolves about it. This theory has been disproven because it could not properly explain the motions of the other planets especially the more distant ones. The explanation for the other planets was "epicycles"



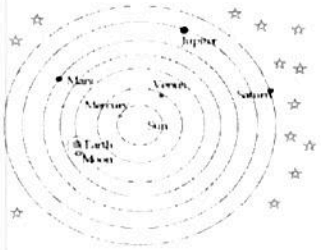
Epicycles

The idea of epicycles was used to try and explain the geocentric model of the solar system. Epicycles would have the planets making circles around its revolution around Earth.



Heliocentric

The Heliocentric model of our solar system states all the planets, many dwarf planets and many other smaller objects revolve about the sun. This idea was proposed by Copernicus and supported by many like Galileo, Kepler and more.

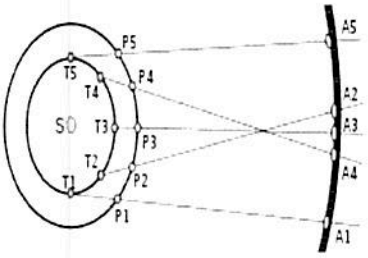


Copernicus

Copernicus was a Renaissance-era mathematician and astronomer who was known for proposing the heliocentric model of the solar system which made more sense than the geocentric model.

Retrograde Motion

Retrograde motion is the apparent backward motion of planet in the heliocentric model. The planets aren't truly moving backwards.

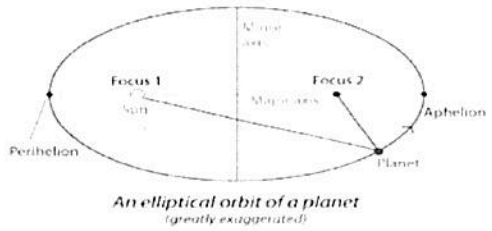


Johann Kepler

Johann Kepler was a German astronomer, mathematician, and astrologer. He is most known for finding the three laws of planetary motion in the early 17th century.

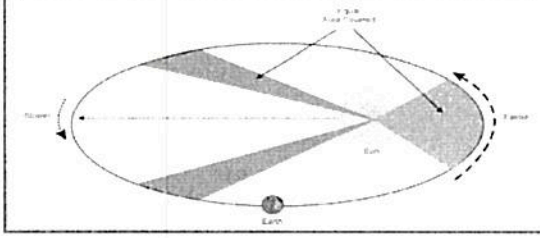
Kepler's 3 Laws of Planetary Motion

Kepler's First Law – The law of Ellipses – This laws states that all planets travel in elliptical orbits with the sun at one focus.

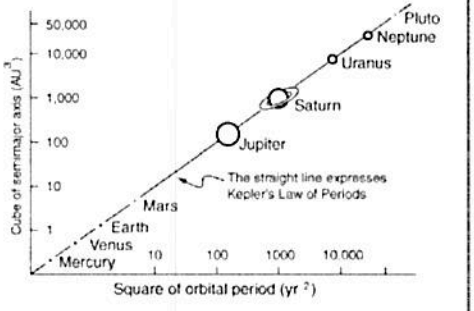


An elliptical orbit of a planet (greatly exaggerated)

Kepler's Second Law- Law of Equal Areas- This law states each planet travels in such a way that a line joining the planet and the sun sweeps equal areas in equal time. In the diagram below the gray areas are equal in area

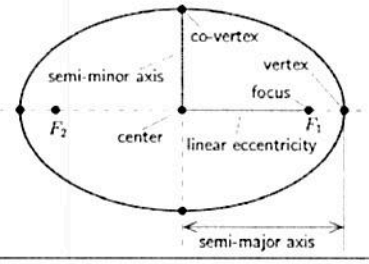


Kepler's Third Law – Law of Harmonies – This law explains a relationship between distance and period: $P_2 = D_3$ it describes how the planets move in harmony with each other- fastest in the center and gradually moving slower towards the outer solar system.



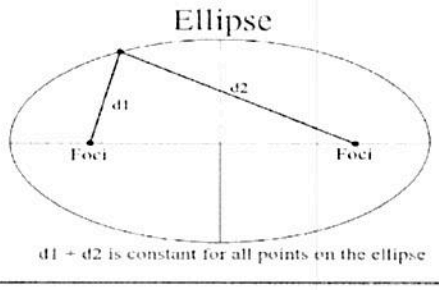
Ellipse

This is the shape of an orbital path that an object (satellite – planet/moon) follows around another object (primary – Sun/Planet). The motion around the object is called revolution



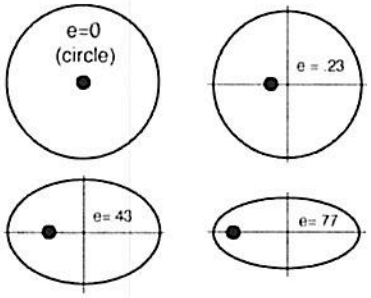
Foci

One of two fixed points on the major axis of an ellipse



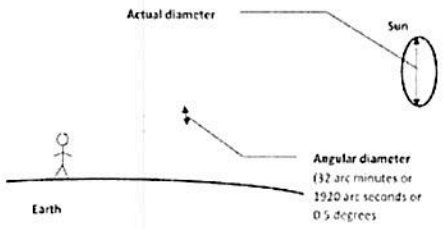
Eccentricity

Eccentricity is a calculation of the "out-of-roundness" of the ellipse. The formula is used to calculate eccentricity as a numerical value of the shape of an ellipse. (note the more eccentric something is the closer it is to a circle.)
Eccentricity of an Ellipse = Distance between foci/Length of major axis



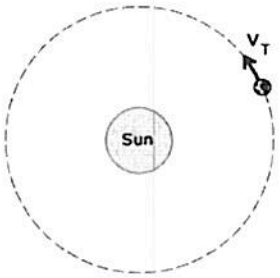
Apparent Diameter

The apparent diameter of a celestial object is the diameter measured from an observer's perspective at a specific distance away from the object. The farther the distance between the observer and object, the smaller the apparent diameter.



Orbital Velocity

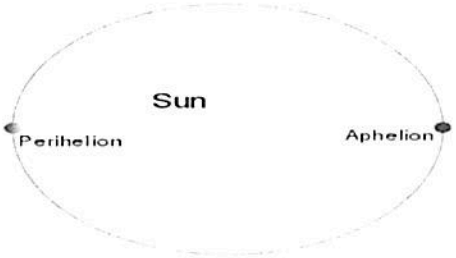
Orbital velocity is the speed of a planets orbit. It is greatest when the object is closet to the object it is orbiting and is least when the object is farther or farthest away from the object it is orbiting.



Perihelion/Aphelion

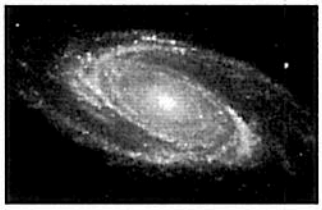
Perihelion is the point of orbit of a planet, asteroid, or comet is closest to the sun and moves fastest and has greater kinetic energy and lower potential energy. The sun will also look larger here.

Aphelion is the point of orbit of a planet, asteroid, or comet is farthest from the sun and moves slowest and has a lower kinetic energy but has a higher potential energy. The sun looks smaller at this position



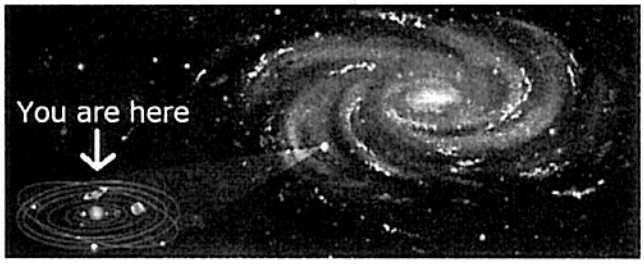
Galaxies

Galaxies are systems of millions to billions of stars packed together with gas and dust, held together by gravitational force.



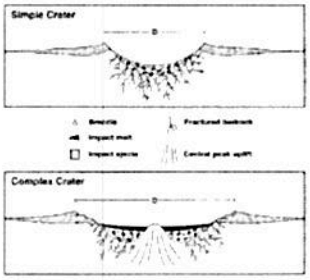
Milky Way Galaxy

The Milky Way Galaxy is a spiral galaxy that we live in. We revolve its center in a counter-clockwise direction. We are located in a arm of the spirals.



Impact Crater

An impact crater is an approximately circular depression in the surface of a moon, planet or other solid body in the universe, formed by impact of an smaller body. Impact craters can be created by comets and asteroids, as well as meteorites, but the shockwave and impact will be much greater.



Constellation (Seasonal)

A constellation is a group of stars forming a recognizable pattern that are traditionally named after its apparent form or identified with a mythological figure. During different seasons you will see different constellations (Shown on diagram) because the earth will be positioned at different points as it orbits the sun, changing what you can see in the night sky.