UNIT 2: ASTRONOMY

Topic 1: Earth's Motion
Topic 2: The Moon – Earth's Satellite
Topic 3: Solar System
Topic 4: The Planets
Topic 5: Stars & Galaxies

Topic 1: Earth's Motion

Essential Question:
What causes the cycle of seasons on Earth?

Topic 1: Earth's Motion

Essential Question: What causes the cycle of seasons on Earth?

Well, what do **YOU** think??

Earth's distance from the Sun?

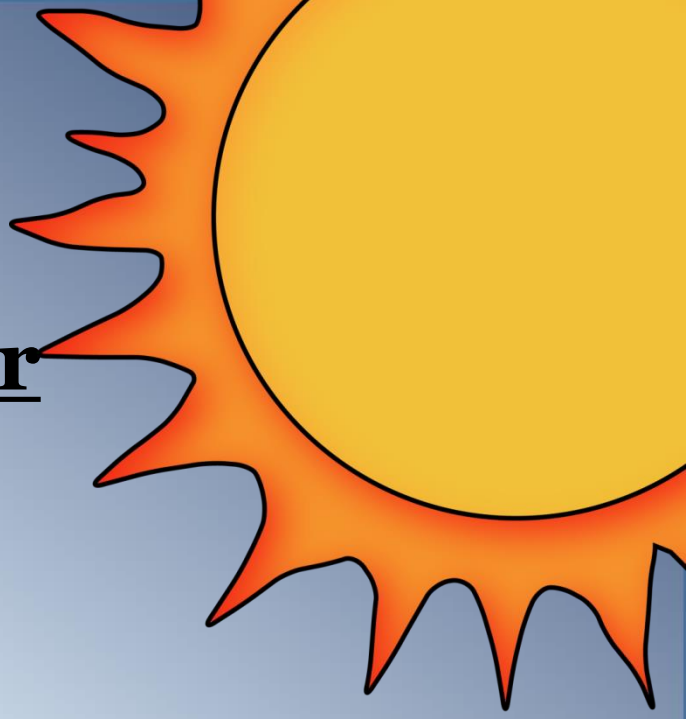
(so it is warmer here when we are closer to the Sun and colder when we are farther away from the Sun)

OR

Earth's tilt?

(so it is warmer here when we are tilted towards the Sun and colder when we are tilted away from the Sun)

Topic 1: Earth's Motion

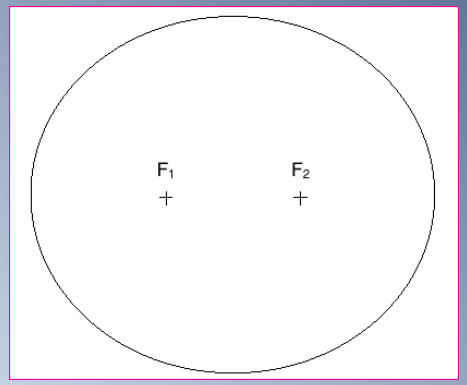


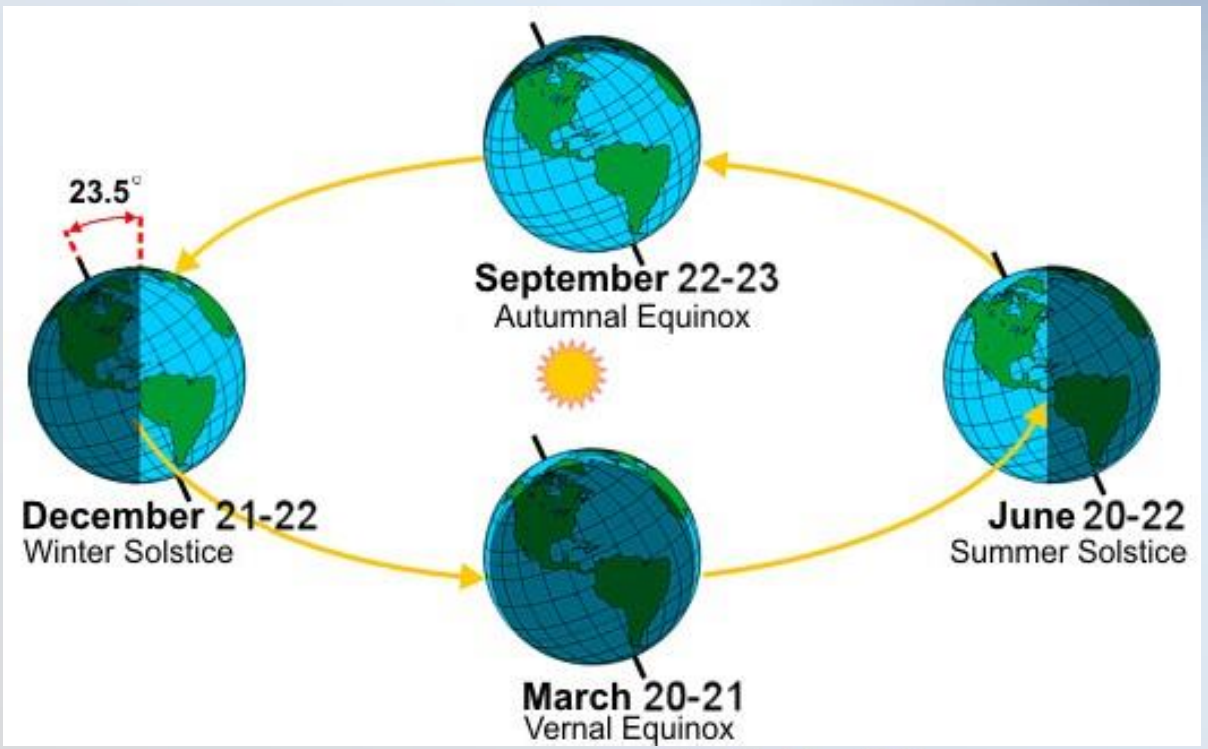
The Sun is the **nearest star to Earth** and has **a diameter 100 times greater than Earth's**.

The Sun's **core reaches temperatures over 15,000,000°C**, with the **surface reaching temps of 5,500°C**. A small part of this energy reaches Earth as light and thermal energy.

Topic 1: Earth's Motion

- Earth **orbits, or follows an ellipitical* path, around the Sun** making one complete revolution every **365.25 days** due to the **Sun's gravitational pull**.
  - Ellipse: **oval shape with 2 foci** (center points)

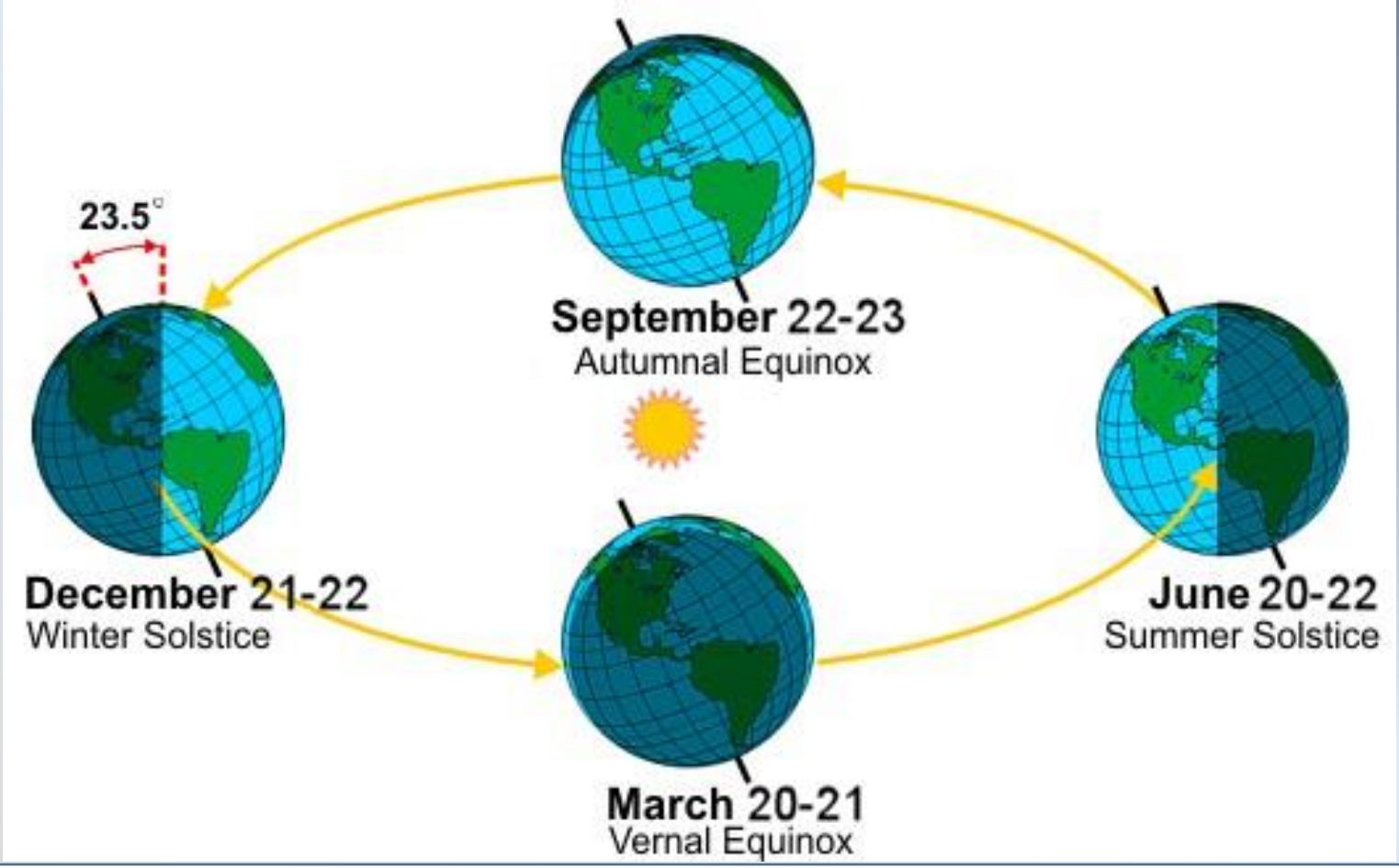




*Note: The fact that Earth's orbit is an ellipse, NOT a circle, is an important idea that we will continue to discuss more soon!

Topic 1: Earth's Motion

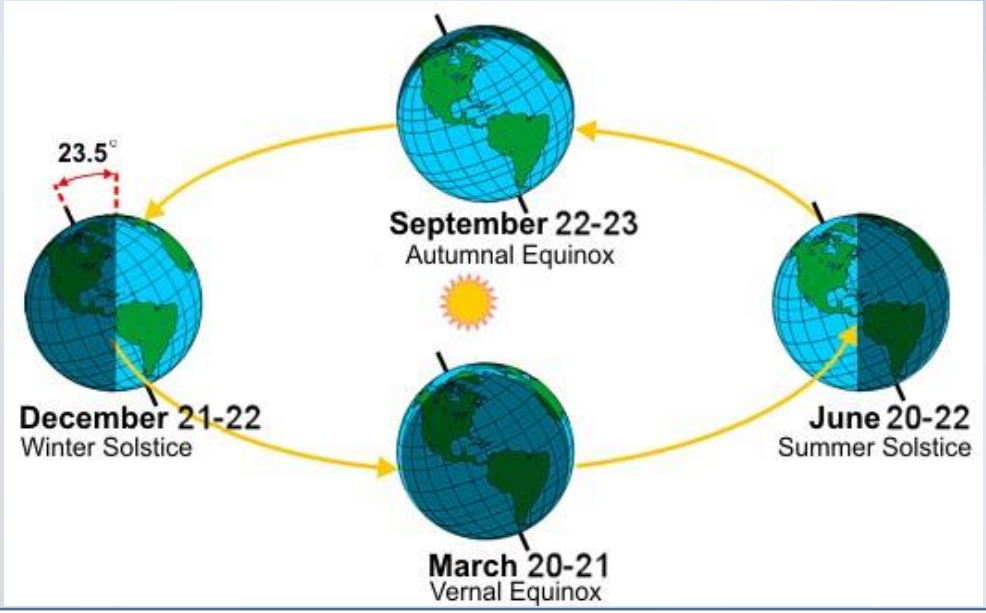
- Earth's elliptical orbit means that **the Sun is not at the center** of its orbit.



Topic 1: Earth's Motion

- Thus **Earth moves closer to and farther away from the Sun** as it orbits.
  - **Perihelion**: **Closer** to the Sun
    - Occurs around **January 3rd**
  - **Aphelion**: **Farther Away** from the Sun
    - Occurs around **July 4th**

Perihelion

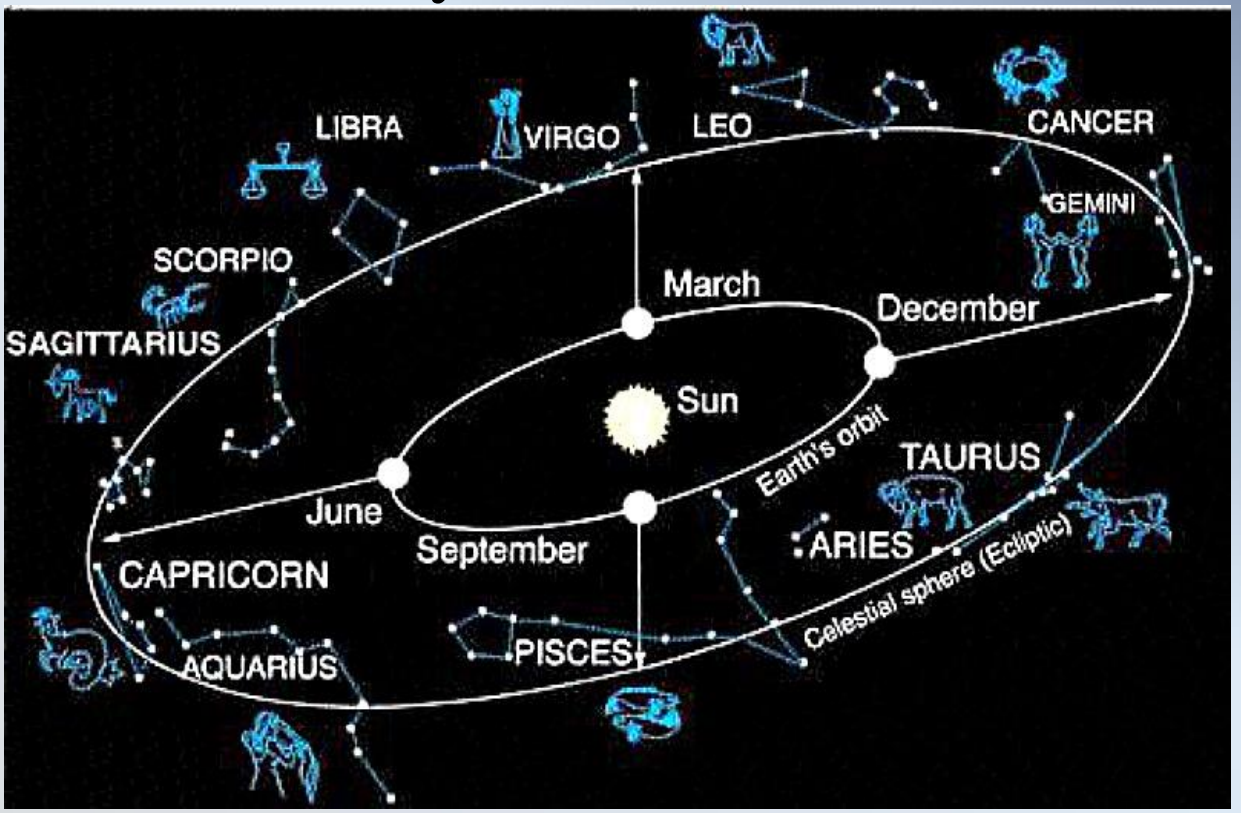


Aphelion

Topic 1: Earth's Motion

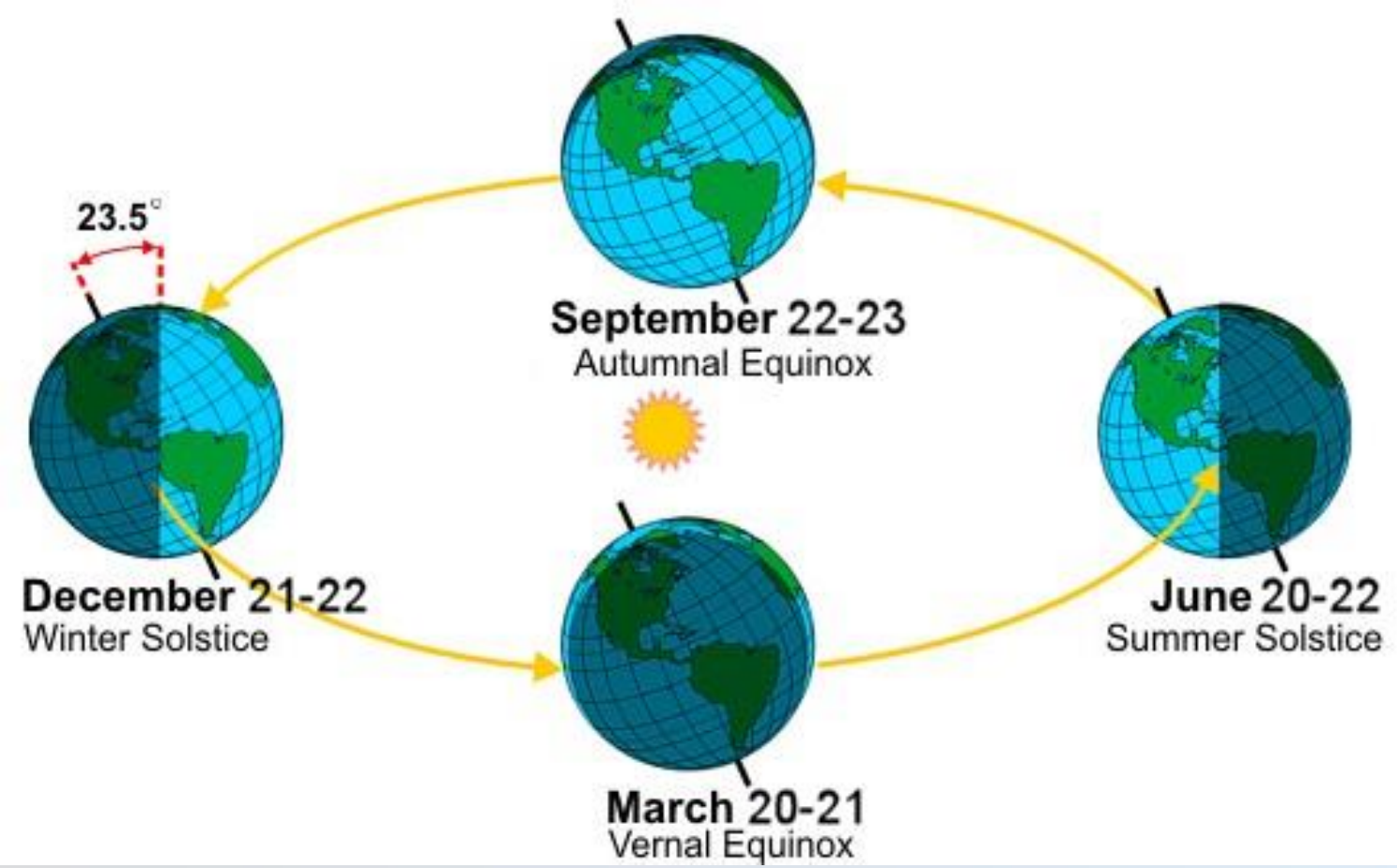
- Evidence for Earth's Revolution:
  - **(1) Changing Constellations:** As Earth orbits the Sun, different constellations can be seen in the sky

FYI…
Constellation: Man-made patterns of stars in the sky



Topic 1: Earth's Motion

(2) Changing Seasons: As Earth orbits the Sun, areas on Earth experience different seasons

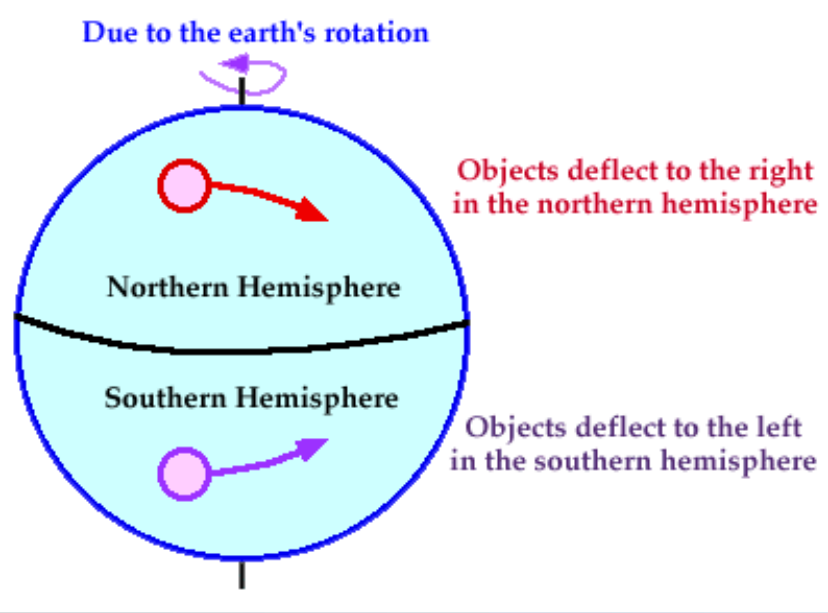


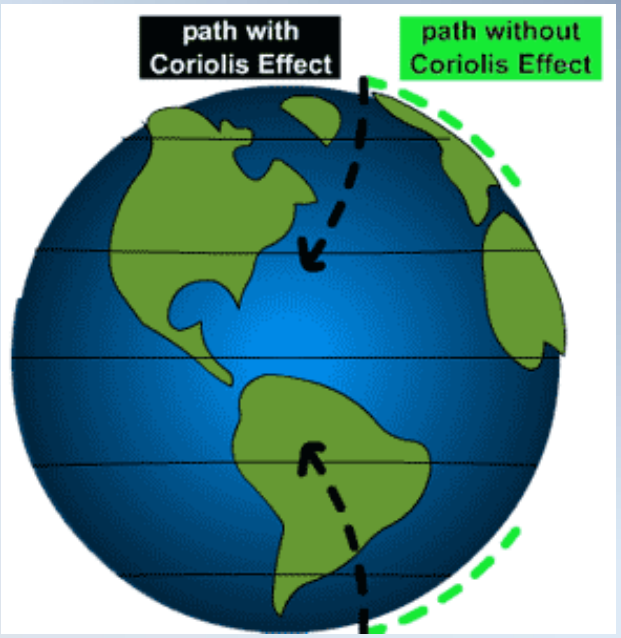
Topic 1: Earth's Motion

- As Earth revolves around the Sun, Earth **<u>rotates, or spins, on its rotational axis</u>** (an imaginary line on which the Earth rotates).

Topic 1: Earth's Motion

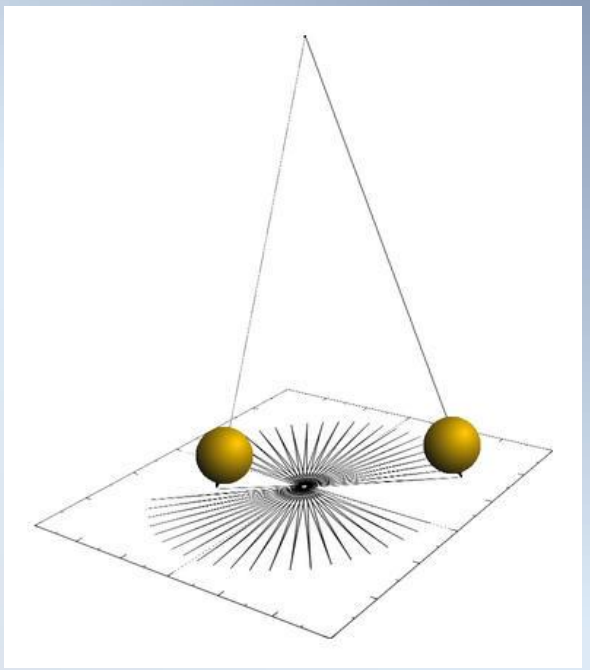
- Evidence for Earth's Rotation:
  - **(1) Coriolis Effect:** the apparent curved motion of fluids (like water or air) on Earth's surface
    - Video Explanation 1
    - Video Explanation 2
    - Video Explanation 3





Topic 1: Earth's Motion

- Evidence for Earth's Rotation:
  - **(2) Foucault's Pendulum:** a pendulum whose movement changes directions over time
    - Video Demonstration 1 (from Space)
    - Video Demonstration 2 (on Earth)



Topic 1: Earth's Motion

The

(1) **tilt of Earth's rotational axis**

+

(2) **Earth's revolution around the Sun**

= **the seasons change**

- Earth's **tilt** and **orbit** cause the sun's radiation to strike the hemispheres at **different** angles.
- The hemisphere **tilted towards the Sun**
  - receives **more daylight hours** than the hemisphere tilted away from the Sun
  - receives **more total sunlight** than the hemisphere tilted away from the Sun

Topic 1: Earth's Motion

Solstice:

Day when **Earth's rotational axis is the most toward or away from the Sun**

- **June (Summer) solstice:** June 20/21 in the northern hemisphere
- **December (Winter) solstice:** Dec 21/22 in the northern hemisphere

Challenge Question

When it is the June (summer) solstice in the Northern Hemisphere, what solstice is happening in the Southern Hemisphere?

Topic 1: Earth's Motion

Solstice:

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Challenge Question

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Winter Solstice

Topic 1: Earth's Motion

Equinox ("equal nights"):

Day when **Earth's rotational axis is leaning along Earth's orbit, neither toward nor away from the Sun**

- **March (Spring/Vernal) equinox:** March 20/21 in the northern hemisphere
- **September (Fall/Autumnal) equinox:** Sept 22/23 in the northern hemisphere

Challenge Question

When it is the September (fall/autumnal) equinox in the Northern Hemisphere, what equinox is happening in the Southern Hemisphere?

Topic 1: Earth's Motion

Equinox ("equal nights"):

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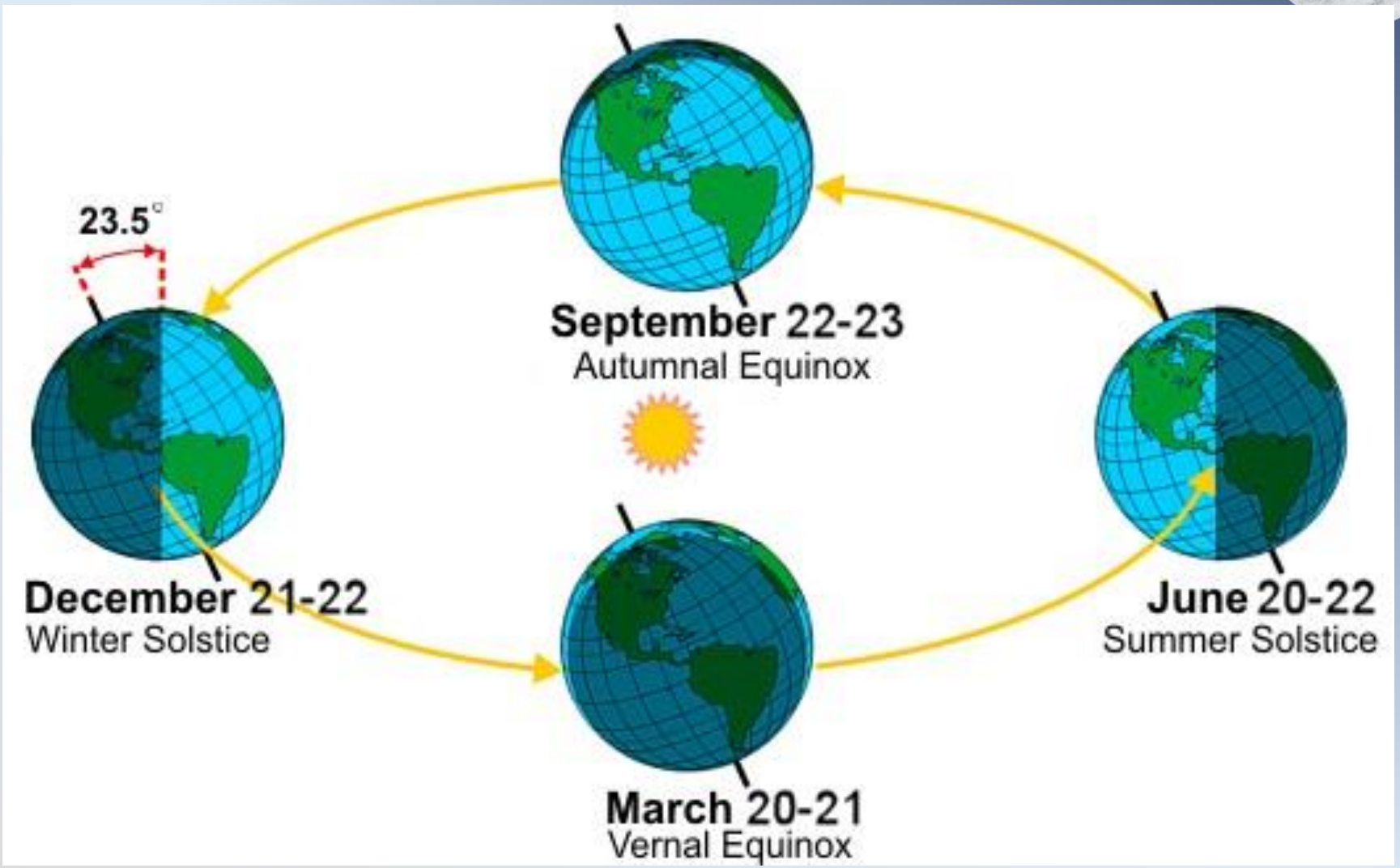
Challenge Question

When it is the September (fall/autumnal) equinox in the Northern Hemisphere, what equinox is happening in the Southern Hemisphere?

Spring/Vernal Equinox

Topic 1: Earth's Motion



Topic 1: Earth's Motion

Practice: Ellipses & Eccentricity

Key Points

- Earth and all the planets in our Solar System travel in **elliptical orbits around the Sun**
- Ellipses can be very **round** (a circle) or very **stretched out** (a straight line)
- **Eccentricity** is how we measure how round or stretched out an ellipse is
- Using p. 1 of your Reference Table, write down the formula for eccentricity here:

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

- Eccentricity values range between **0 and 1**
  - **0 = circle**
  - **1 = straight line**

Questions?

Topic 2: The Moon – Earth's Satellite

Essential Question:
Why does the moon appear to change shape?

Topic 2:
The Moon – Earth's Satellite

The Moon appears to shine because it **reflects the Sunlight**.

Topic 2:
The Moon – Earth's Satellite

The **gravitational pull** of Earth on the Moon causes the Moon to move in an orbit around the Earth.

The **changing relative positions** of the Moon, Earth and Sun cause the **phases of the Moon, eclipses and tides**.

Topic 2:
The Moon – Earth's Satellite

Phases – the **different forms the Moon takes in its appearance** from Earth; the sequence of phases is called the **lunar cycle** and lasts **29.5 days**

Topic 2:
The Moon – Earth's Satellite

new moon – when the **moon is between Earth and Sun** and **can't be seen**

Draw a new moon, like the one above, in the circle in your notes

Topic 2:
The Moon – Earth's Satellite

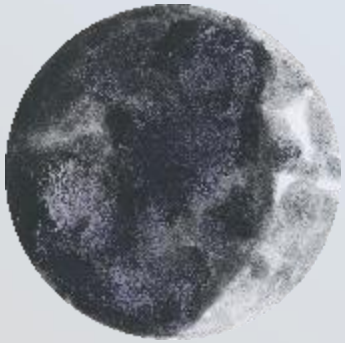
full moon – when the **Earth is between the moon and Sun** and the **moon can be fully seen**

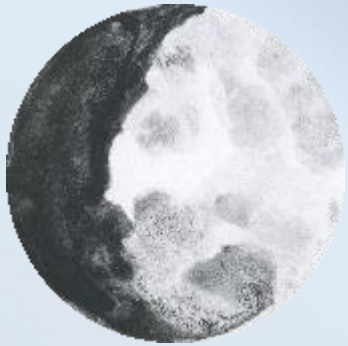
Draw a full moon, like the one above, in the circle in your notes ;) (don't over-think this one!)

Topic 2:
The Moon – Earth's Satellite

<u>Waxing Phases</u>: More of the moon's **<u>right side is bright</u>** each night

- **<u>waxing crescent</u>** – first visible thin slice of moon on right
- **<u>first quarter</u>** – right half of the lighted side of moon is visible
- **<u>waxing gibbous</u>** – more than one quarter of right side is visible

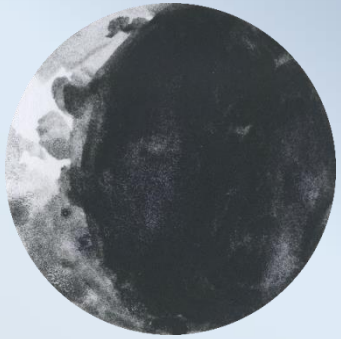




Topic 2:
The Moon – Earth's Satellite

<u>Waning Phases</u>: **<u>Less</u>** of the illuminated half of Moon is visible after a full moon

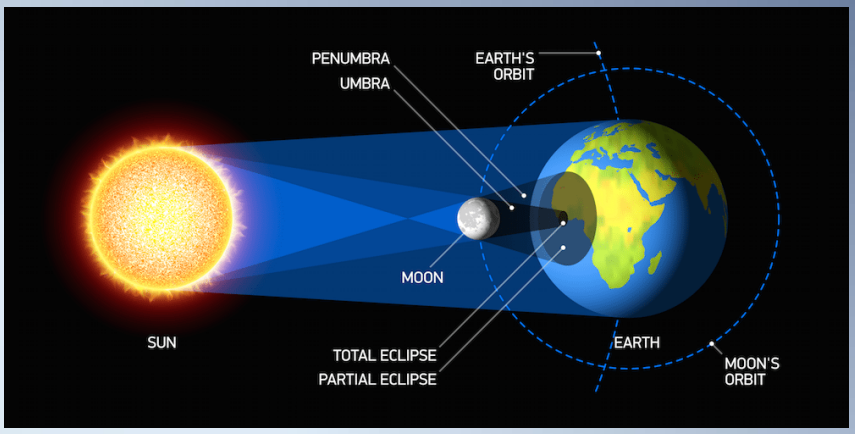
- **<u>waning gibbous</u>** – starts after a full moon when more than half of bright side of moon is still visible on left
- **<u>Third or last quarter</u>** – only half the moon's lighted side on left is visible
- **<u>waning crescent</u>** – last visible slice on the left before a new moon



Topic 2:
The Moon – Earth's Satellite

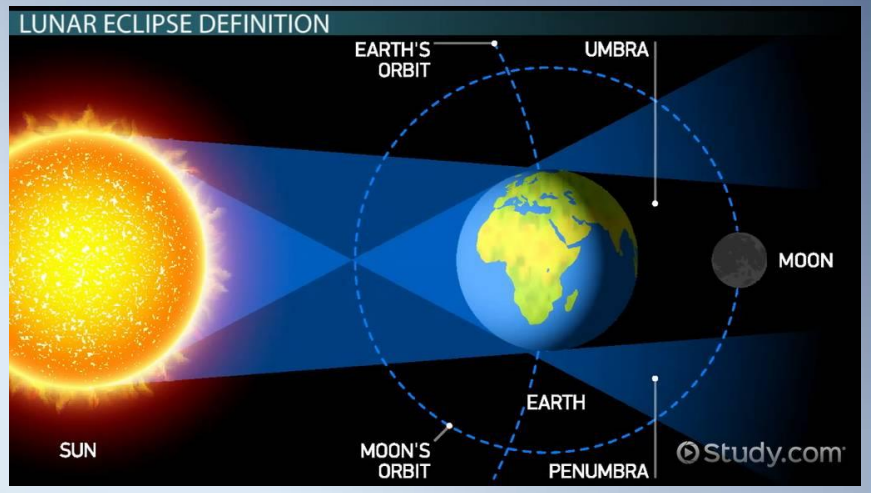
Eclipse: When **Earth or the Moon casts a shadow on the other**

- **solar eclipse** – when Moon's shadow appears on Earth's surface
  - Moon appears to block the Sun



Topic 2:
The Moon – Earth's Satellite

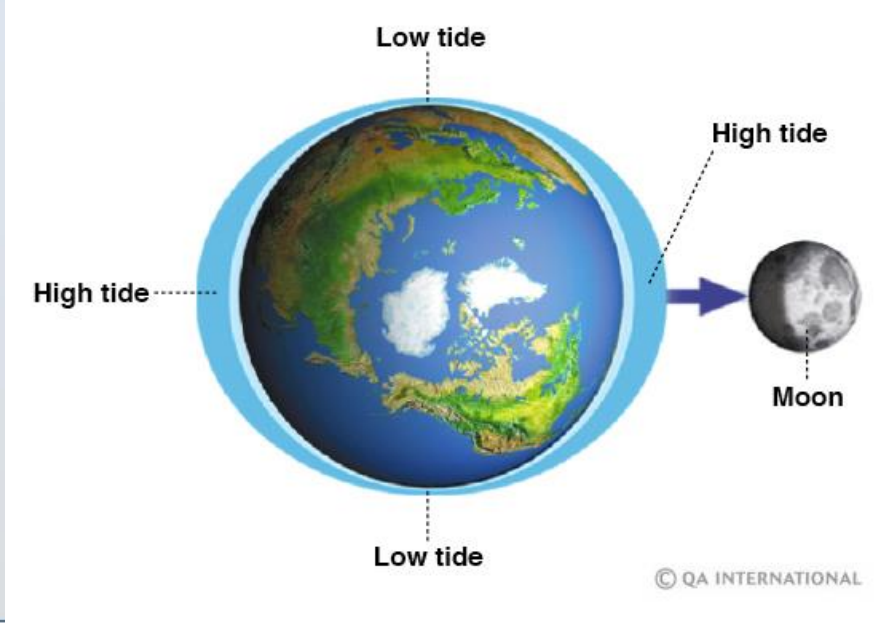
- **<u>lunar eclipse</u>** – occurs when the Moon moves into Earth's shadow
  - Earth appears to darken the Moon



Topic 2:
The Moon – Earth's Satellite

Tide: The **rising and falling water levels on Earth** caused primarily by the **moon's gravity** and usually found in large bodies of water

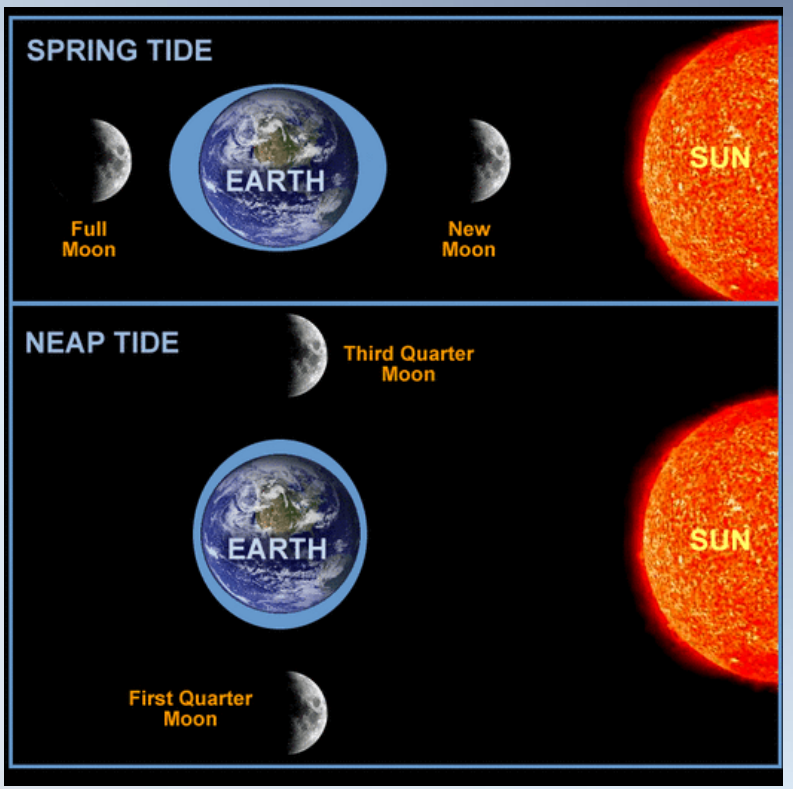
- Video Explanation

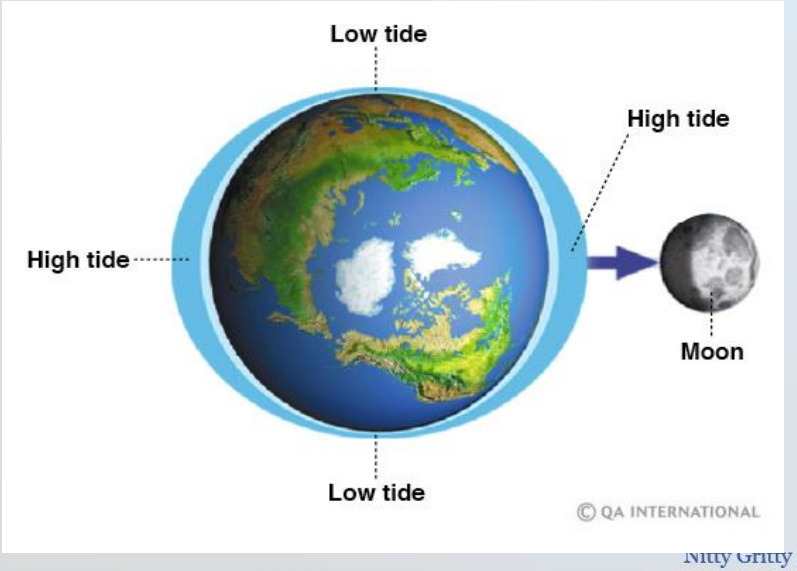


Topic 2:
The Moon – Earth's Satellite

- **<u>High Tide</u>**– Higher water levels
  - Spring Tide: "Higher than normal" high tides
  - Neap Tide: "Lower than normal" high tides

- **<u>Low tide</u>**– Lower water levels





Topic 2:
The Moon – Earth's Satellite

Features of Moon's surface

maria – dark, flat areas formed from lava 3-4 billion years ago

crater – large, round pits caused by impacts of meteoroids

highlands – oldest, most highly-cratered regions on the Moon

These features are easier to see because **the Moon has no atmosphere** to protect it or erode away the features.

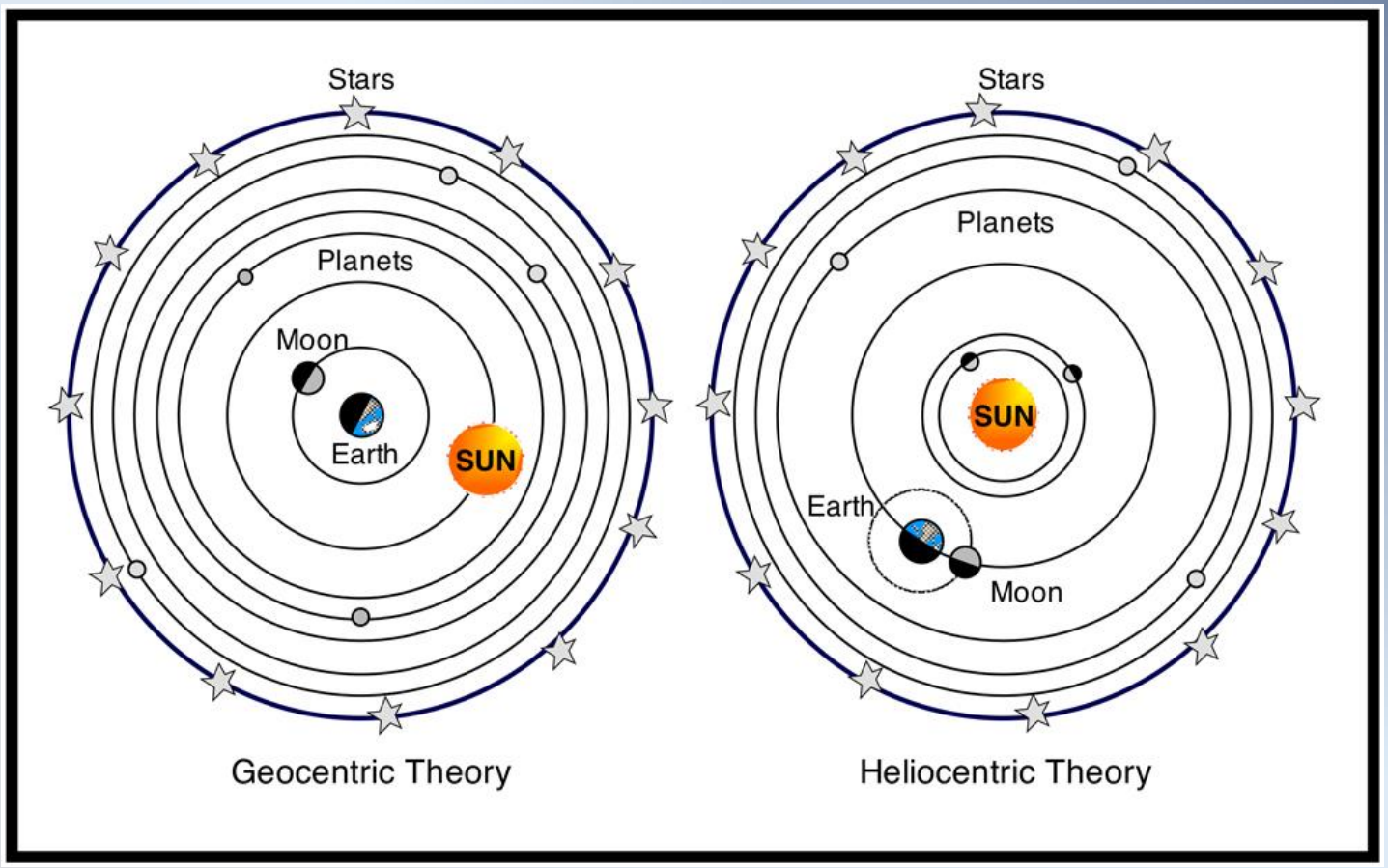
Questions?

Topic 3:
Solar System

Essential Question:
How did the solar system form?

Topic 3: "Solar System"

Geocentric vs. Heliocentric Models of the Solar System



Topic 3: "Solar System"

<u>Geocentric (Earth-centered) model</u>: early Greeks thought planets, the Sun, Moon and stars **<u>revolved around the earth</u>**

<u>Heliocentric (Sun-centered) model:</u> Nicholas Copernicus and Galileo Galilei observed that the Moon revolved around the Earth and that Earth and the other planets **<u>revolved around the Sun</u>**

Topic 3: "Solar System"

Astronomical units (AUs):

Measures distances among the objects in the solar system: **1 AU = 150 million km**, the average distance from Earth to the Sun

Planet	Average Distance from Sun
Mercury	.387 AU
Venus	.722 AU
Earth	1.0 AU
Mars	1.52 AU
Jupiter	5.2 AU
Saturn	9.58 AU
Uranus	19.2 AU
Neptune	30.1 AU

Topic 3: "Solar System"

Astronomers believe the **solar system began 4.6 billion years ago**.

A cloud of **gas, ice and dust** formed slowly.

Shock waves (possibly from a **supernova**, or exploding star) might have caused the cloud to compress.

Cloud became **more dense, rotated faster, heated up, and flattened** to form a disc

Topic 3: "Solar System"

Heated material from the contracting cloud triggered **<u>nuclear fusion</u>**, forming the Sun

Material left behind became objects in the solar system, including the **<u>planets, dwarf planets, asteroids, comets, and meteoroids</u>**

Topic 3: "Solar System"
Objects that orbit the Sun

- planets – a planet must **orbit the Sun**, have a **nearly spherical shape** and have a **much larger mass** than the total mass of all other objects

- dwarf planets – **spherical-shaped** object that **orbits the Sun** but has **less mass** than the objects in nearby orbits

- asteroid – millions of **small, rocky objects** that **orbit the Sun** in an **asteroid belt**; range in size from < 1 meter to several hundred km

Topic 3: "Solar System" Objects that orbit the Sun

- comet – made of **gas, dust and ice** and **moves around the Sun** in an **elliptical orbit**

- meteoroids – **debris** left by colliding **asteroids** or **comets**

Questions?

Topic 4:
The Planets

Essential Question:
Why are planets classified as either inner or outer planets?

Topic 4: "The Planets"

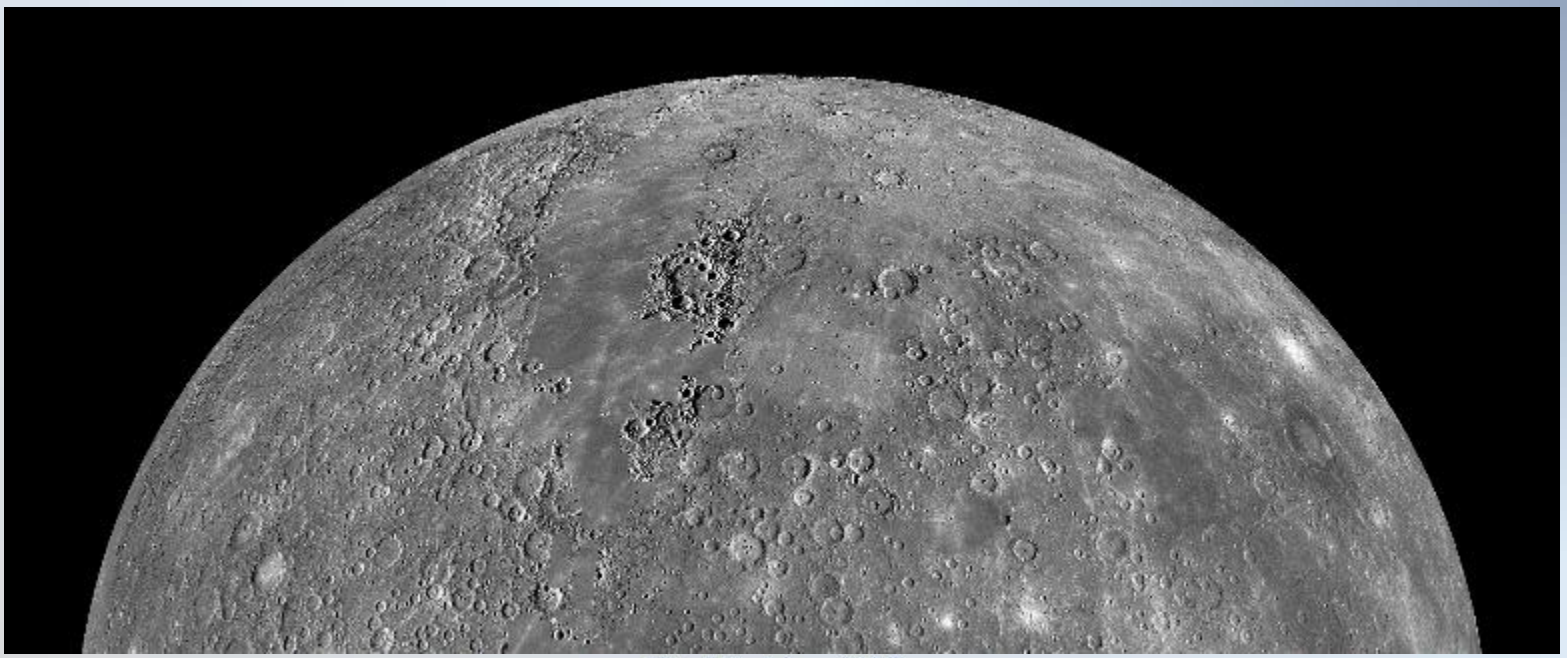
Planets are classified according to their **location** in the solar system.

Inner (terrestrial) planets are those with orbits **between the Sun and asteroid belt**. They are made mainly of **rocky** material.

Outer (Jovian or gas giants) planets orbit **outside the asteroid belt.** They are giant, gaseous planets made mainly of **ice and gas**.

Topic 4: "The Planets" Mercury

- Planet **closest to Sun**
- has **no true atmosphere**; surface temperatures are extreme
- has **many craters** and long, steep cliffs



Topic 4: "The Planets"
Venus

- **Second from Sun** and **similar to Earth** in size and mass
- **extremely dense atmosphere** of clouds causing **intense greenhouse effect** resulting in surface temps between 450°C and 475°C

Topic 4: "The Planets" Earth

- **Third planet** from the Sun
- **water** exists on Earth as solid, liquid and gas
- **atmosphere protects surface** from meteors and Sun's radiation

Topic 4: "The Planets"
Mars

- **Fourth planet** from the Sun
- called the **"red planet"** because of the iron oxide that is present in the surface rocks giving them reddish color
- **thin atmosphere** causing extreme temperatures, strong winds and global dust storms
- has polar ice caps, seasons, and other evidence that water is or was once present

Topic 4: "The Planets"

Jupiter

- **Largest planet** in solar system; **fifth** from Sun
- atmosphere mostly **hydrogen and helium**; many high pressure gas storms with the most notable being the **Great Red Spot**
- has at least **60 moons** with four having their own atmosphere

Topic 4: "The Planets" Saturn

- **Sixth planet** from Sun, **second largest** in solar system
- **thick outer rings** of hydrogen, helium, ammonia, methane and water vapor
- **31 moons**, with largest moon, Titan, being larger than Mercury

Topic 4: "The Planets" Uranus

- **Seventh planet** from Sun; large and gaseous
- **methane** in atmosphere gives planet it blue-green color
- has **tilted axis of rotation** moving around Sun like a rolling ball

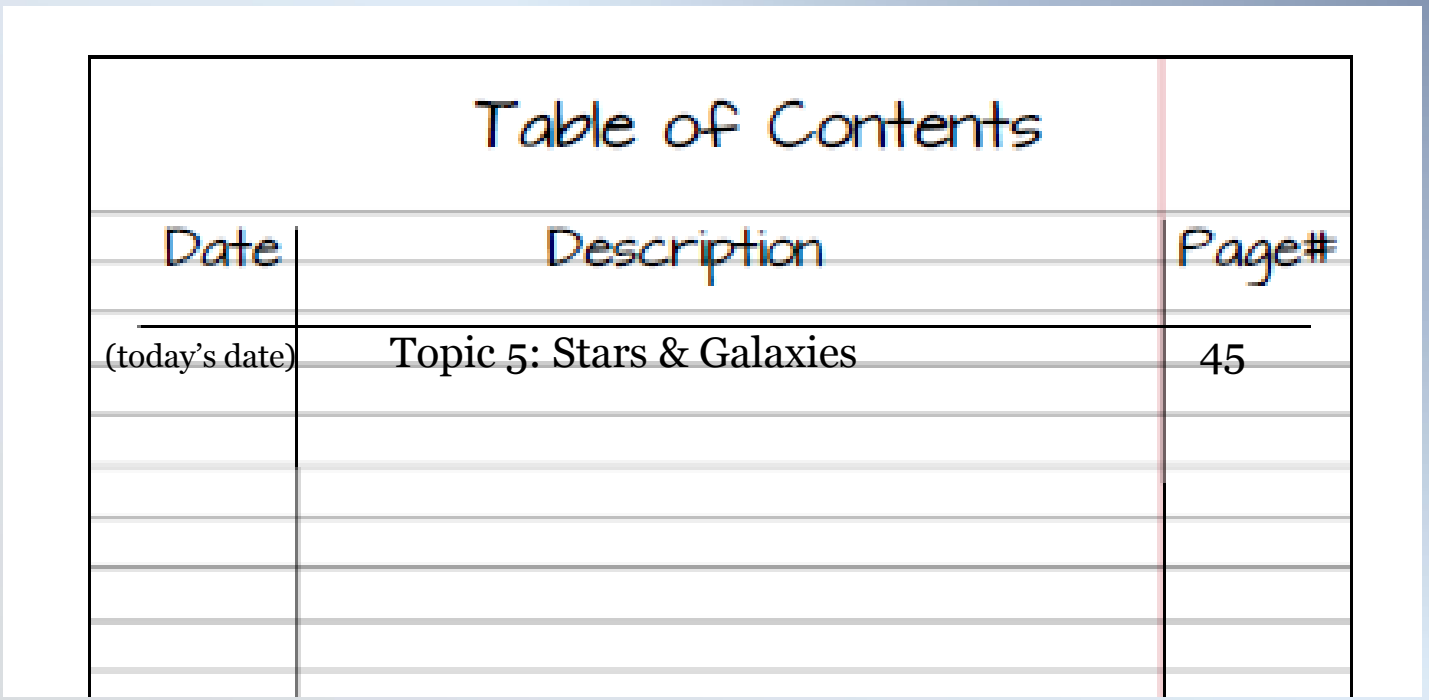
Topic 4: "The Planets" Neptune

- **<u>Eighth planet</u>** from Sun
- has surface of **<u>frozen nitrogen</u>** and geysers that erupt nitrogen gas

Questions?

Topic 5: Stars & Galaxies

Take out your science notebook and turn to the Table of Contents. Fill in the following information:



Topic 5: Stars and Galaxies

Essential Question: What does the life cycle of a star depend on?

Topic 5: "Stars & Galaxies"

Ancient Greeks, Romans and other early cultures observed **patterns of stars in the night sky** called **constellations**.

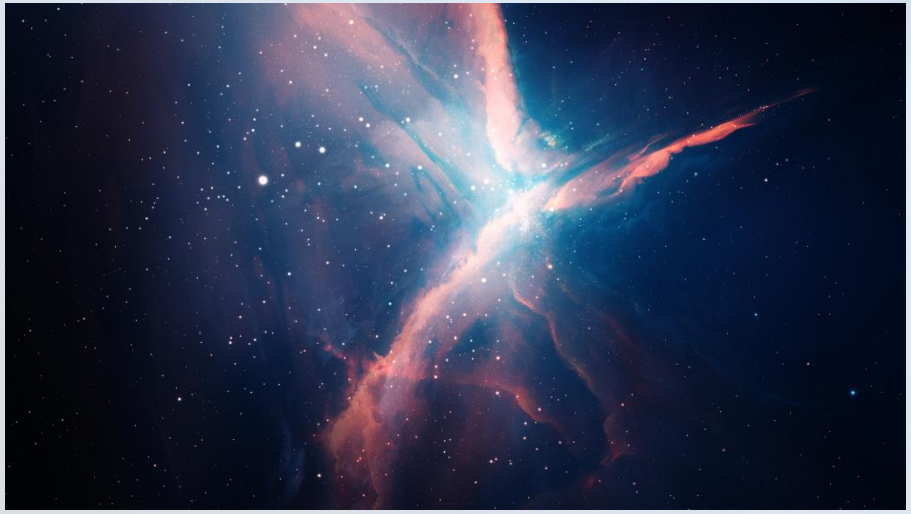
Stars in the sky can be found **at specific locations within a constellation**.

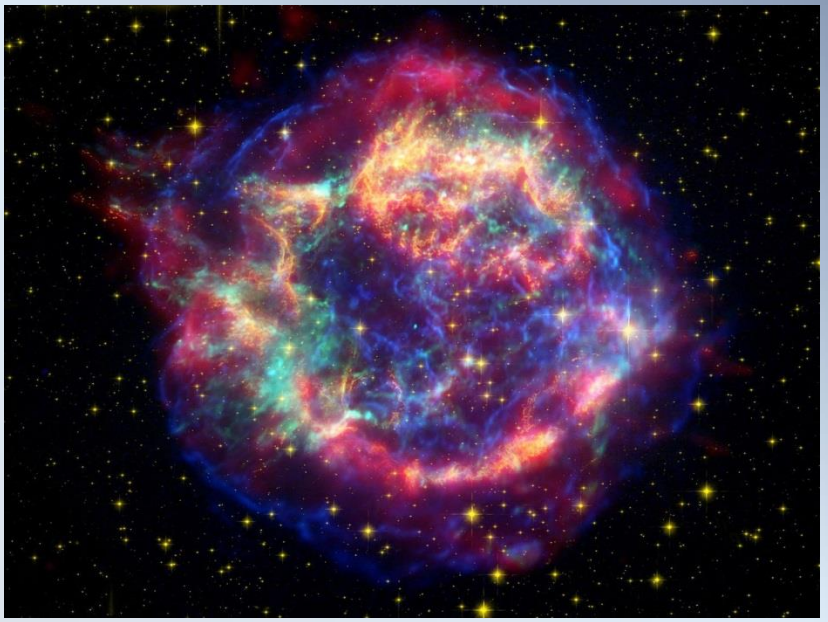
Characteristics used to classify stars include **color, temperature, size, composition and brightness**.

Topic 5: "Stars & Galaxies"

Life of a Star

- A star is "born" when the contracting **gas and dust** from a **nebula**, or large cloud, become so dense and hot that **nuclear fusion** starts.

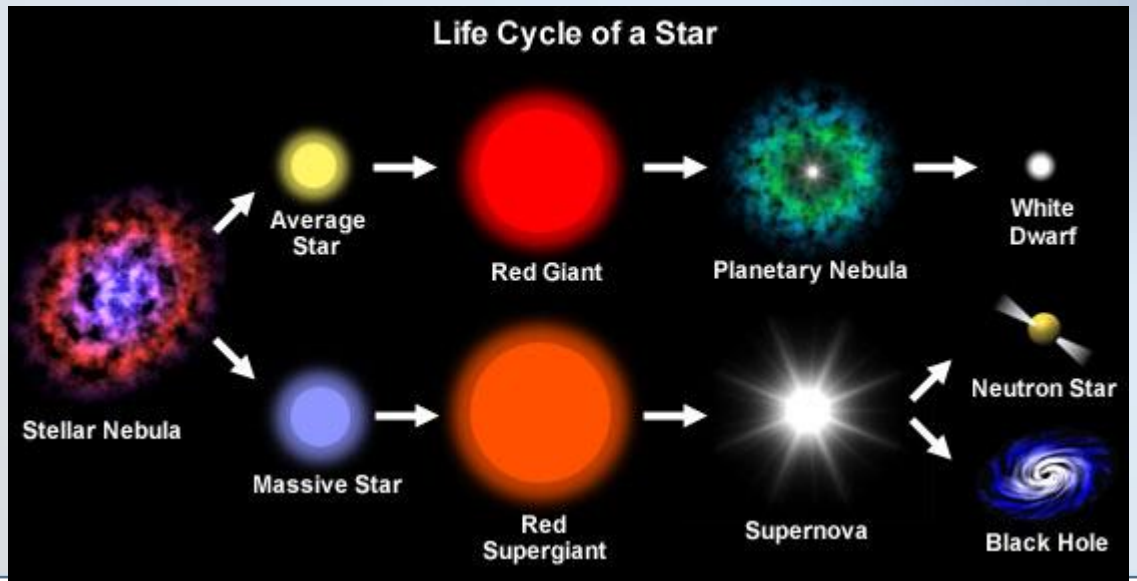




Topic 5: "Stars & Galaxies"

Life of a Star

- A star is "born" when the contracting **gas and dust** from a **nebula**, or large cloud, become so dense and hot that **nuclear fusion** starts.
- After a star runs out of fuel, it becomes a **white dwarf, a neutron star, or a black hole**.
  - What it becomes depends on its **mass**



Topic 5: “Stars & Galaxies”

Star systems

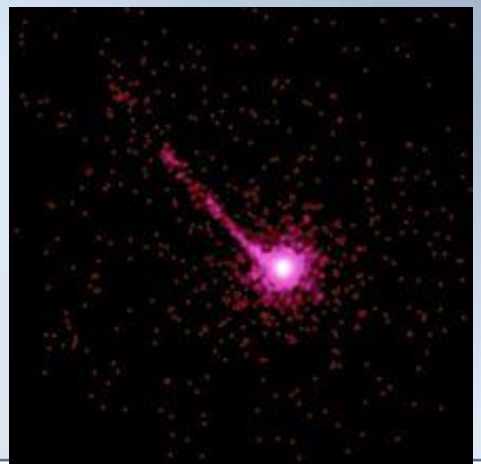
- Most stars are members of groups of two (binary) or more stars called **star systems**.
- **galaxy** – huge group of single stars, star systems, star clusters, dust and gas bound together by **gravity**

Topic 5: "Stars & Galaxies"

Types of galaxies

- **spiral** – has bulge in middle and arms spiral outward; Milky Way
- **elliptical** – round or flattened balls; contain only old stars
- **irregular** – no regular shapes; generally bright, young stars
- **quasars** – active young galaxies with black holes at their centers

In the space in your notes, draw a picture of a quasar.



Questions?

Topic 5: Stars & Galaxies

Sub-Topic: Measuring Light & the Origin of the Universe

Essential Question: What evidence exists that supports the Big Bang Theory?

Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

Measuring Light:

absolute magnitude – measure of the amount of light a star gives off

apparent magnitude – measure of the amount of light received on Earth

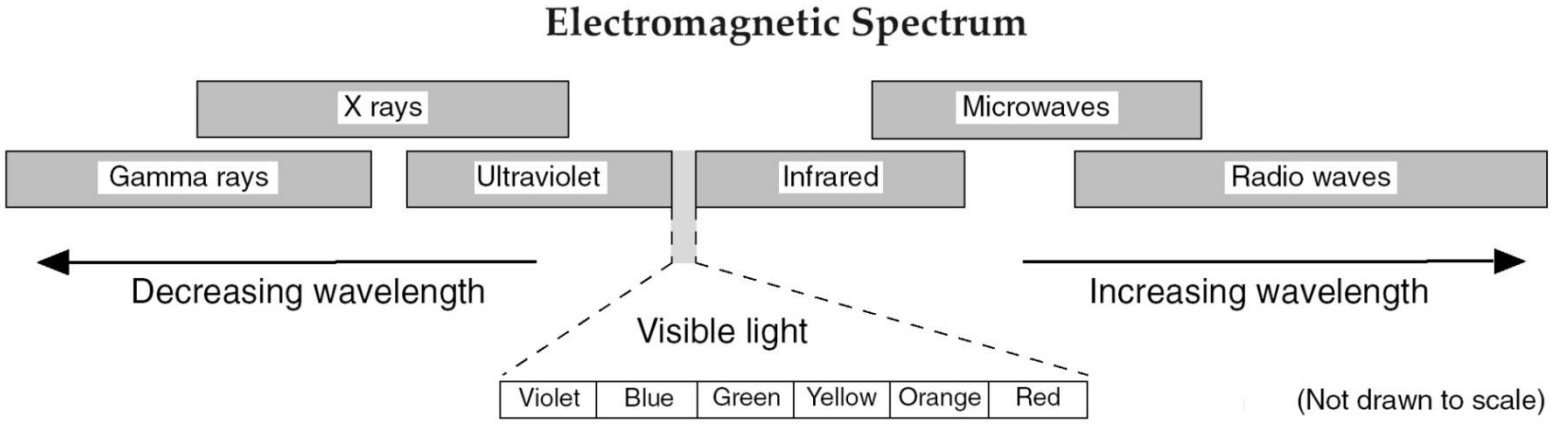
light-year – distance that light travels in one year; light travels at 300,000 km/s or about 9.5 trillion km in one year.

Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

Electromagnetic (E/M) Spectrum

- Includes all electromagnetic waves (**Gamma rays, X rays, UV rays, visible light, infrared energy, microwaves, and radio waves**)
- Waves are organized according to **frequency** (how many waves pass a point over a certain length of time) and **wavelength** (the distance between or how long the waves are)
- ESRT page 14:

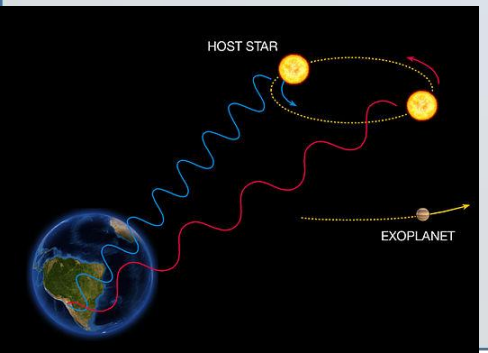


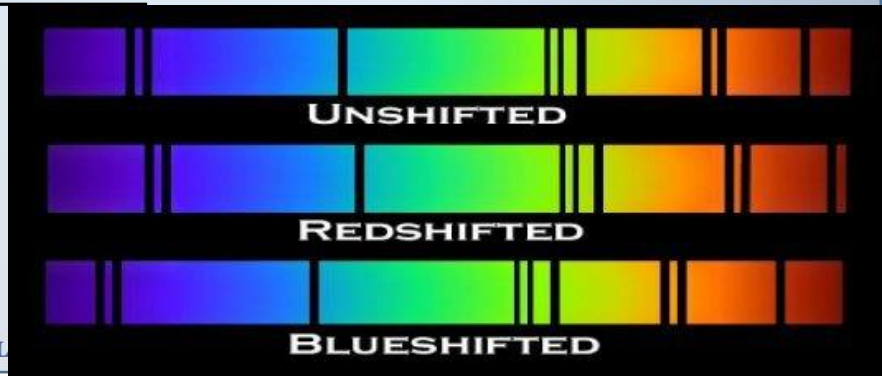
Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

Electromagnetic (E/M) Spectrum

- Scientists study the **spectra, or range of wavelengths of light**, stars emit using an instrument called a **spectroscope** which can **spread the light into different wavelengths**.
  - If the stars are moving, their emitted wavelengths move as well
    - **Red Shift = Moving Away**
    - **Blue Shift = Moving Towards**



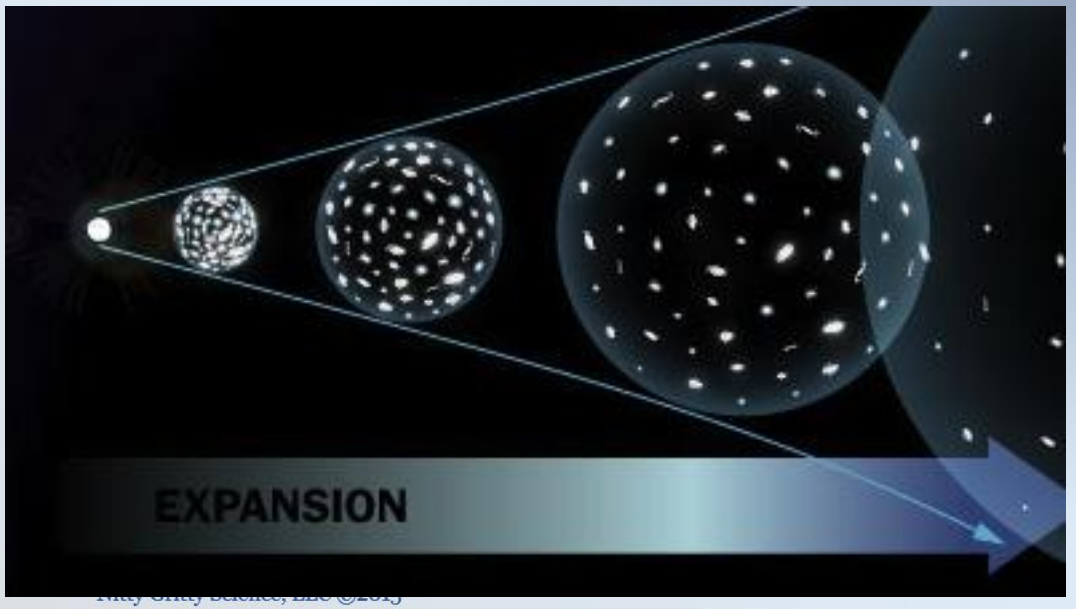


Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

The Big Bang Theory

- Universe probably began about **13.7 billion years ago** with an **enormous explosion** called the **Big Bang**.
- Universe is believed to **still be expanding** from this explosion.

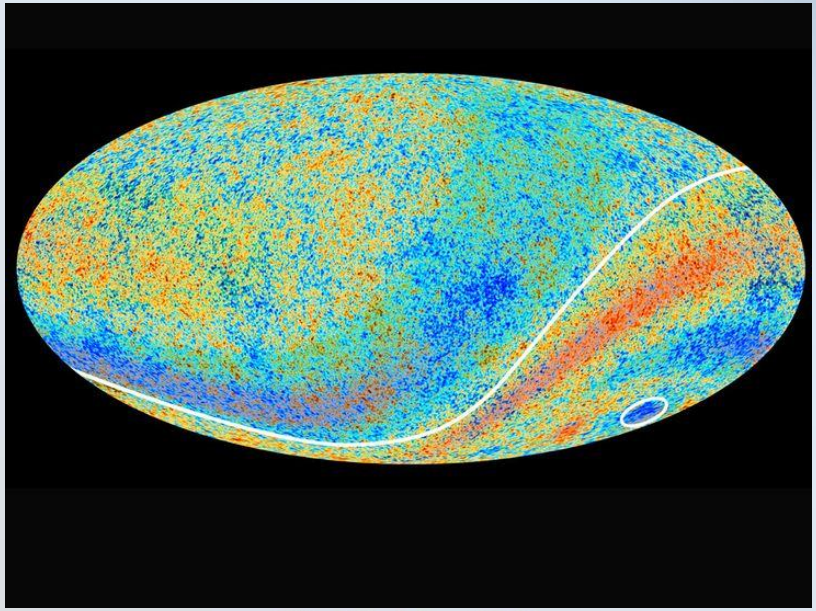


Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

The Big Bang Theory

- Expanding Universe/Big Bang Theory Evidence:
  - Evidence #1: **Cosmic (Microwave) Background Radiation**
    - Energy leftover from the Big Bang explosion

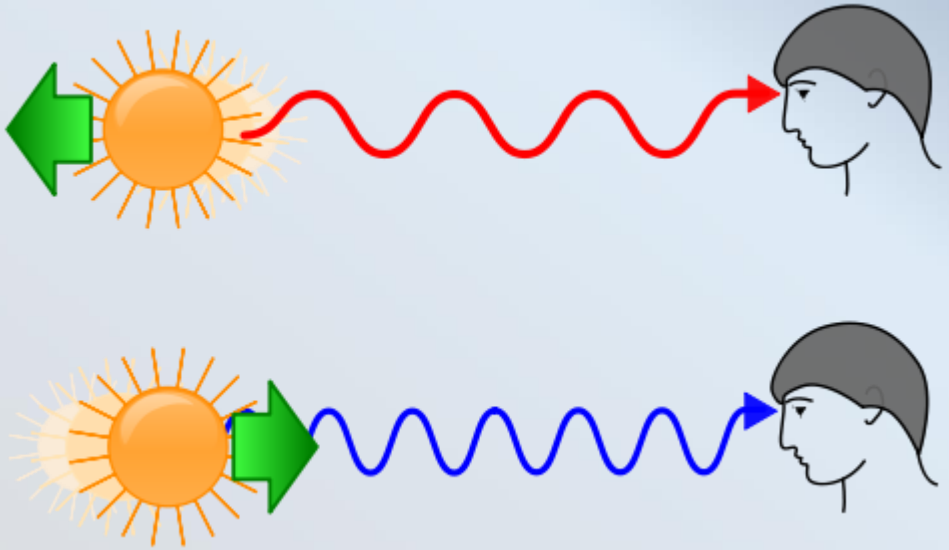


Topic 5: "Stars & Galaxies"

Sub-topic: Measuring Light & the Origin of the Universe

The Big Bang Theory

- Expanding Universe/Big Bang Theory Evidence:
  - Evidence #2: **The Red Shift**
    - Almost everything in the universe appears to be red-shifted (moving away from each other)



Questions?