Earth Science 11 - Week 6: May 19 – May 22

Anticipated time required: 3 hours

New learning objective: **Our Solar System and The Lifecycle of a Star**

Goals to be completed:

1. Read through the notes and videos within this package for section 1 (the solar system) and section 2 (the lifecycle of a star)

2. Complete Worksheet 1 and Worksheet 2 as labelled and submit them

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This PDF package contains several notes, examples and videos. Please read through the lesson package and watch all of the videos included within it. The formal portions to submit are indicated throughout the package. These can be sent to Charlie.feht@yesnet.yk.ca either as a scanned and uploaded PDF attachment to email, or as a jpeg image file.

Upcoming next week:

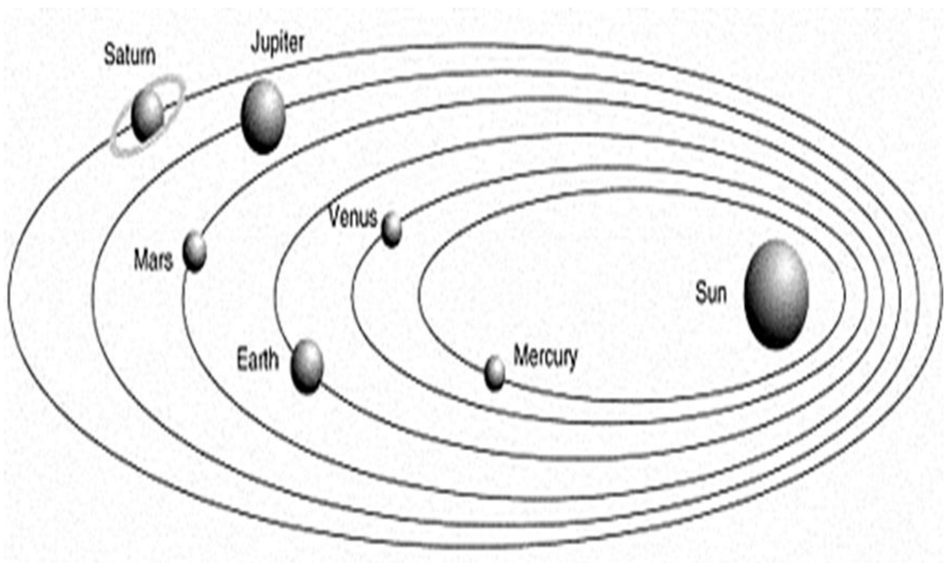
Ocean Currents and Monitoring Water System Health

Section 1: The Solar System

**Introduction**

Our solar system is composed of 8 planets that orbit the sun along predictable elliptical orbits as first outline by Johannes Kepler in 1609. Contrary to popular belief, these planets do not form perfect circles around the sun, but rather, varying oval lengths corresponding to the time of rotation. A larger elliptical requires a larger time to orbit the sun, as you can see in the image of the first 6 planets in the image below.

**Kepler's Elliptical Orbits**



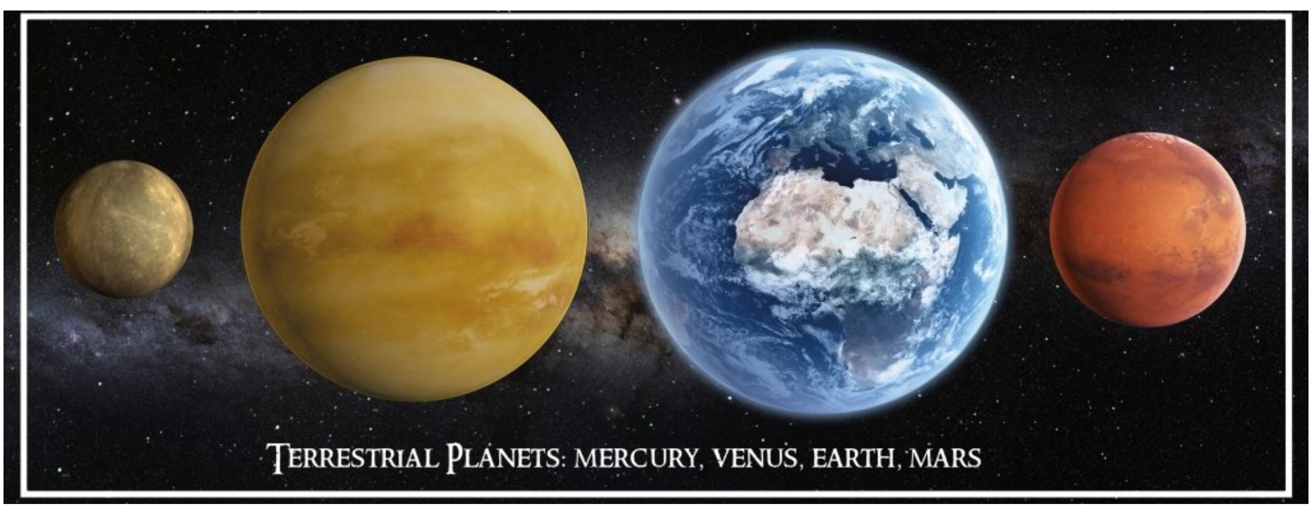

Check out the video below on what exactly an ellipse is, and how Kepler cam to postulate this idea:

https://www.youtube.com/watch?v=qDHnWptz5Jo

It is known that all the planets in our solar system orbit around the sun. There are, however, more than just planets that occupy space in our solar system. Among some of these celestial objects include asteroid belts, comets, meteors and various moons, to name a few. Let's take a look at what a generalized image of the solar system looks like:

**The Inner Planets (Mercury, Venus, Earth, Mars):**

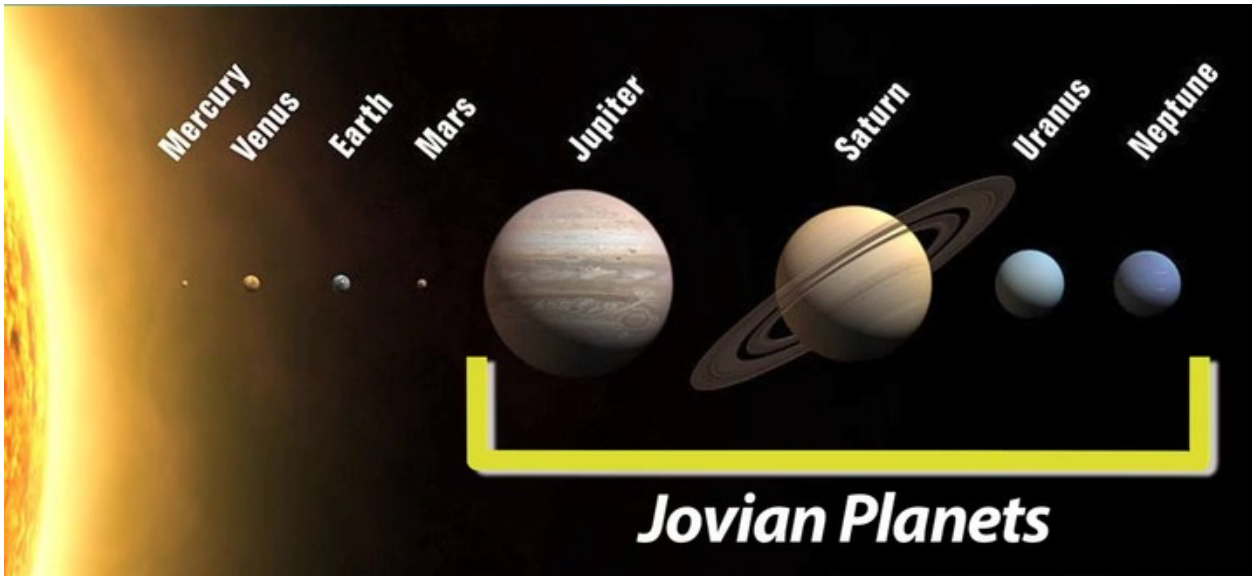
These planets are commonly referred to as **terrestrial planets** because all four of them are composed of rock. The reason for this stems from the formation of the sun. As the sun was growing in size and forming 9 billion years ago, the gravity it exerted on nearby elements floating in space caused the heavier ones like iron, silica, carbon, and nickel to be pulled inwards towards a much closer location to the sun. These elements are what formed the four terrestrial (rocky) planets. This is why earth as an iron/nickel core, and why the four inner planets are so much smaller and denser than the four outer planets.



Check out the video below describing some more details about the terrestrial planets:
https://www.youtube.com/watch?v=ZtoU6u05mog

**The Outer Planets (Jupiter, Saturn, Uranus, Neptune):**

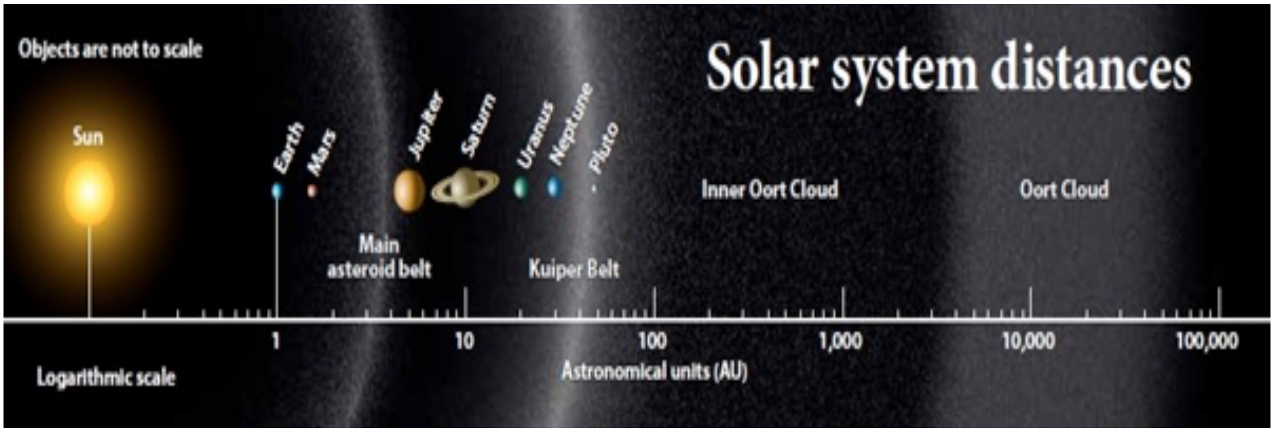
These planets are typically referred to as **Jovian planets** (named after Jupiter) and are elsewise considered to be "gas giants". Unlike the four terrestrial planets, these are all composed of gas. Since they have low density and a gaseous form, these planets are able to grow to immense sizes when compared to the earth like planets.




Check out the video below which describes the Jovian planets in greater detail:

https://www.youtube.com/watch?v=edqSVYXjFAA

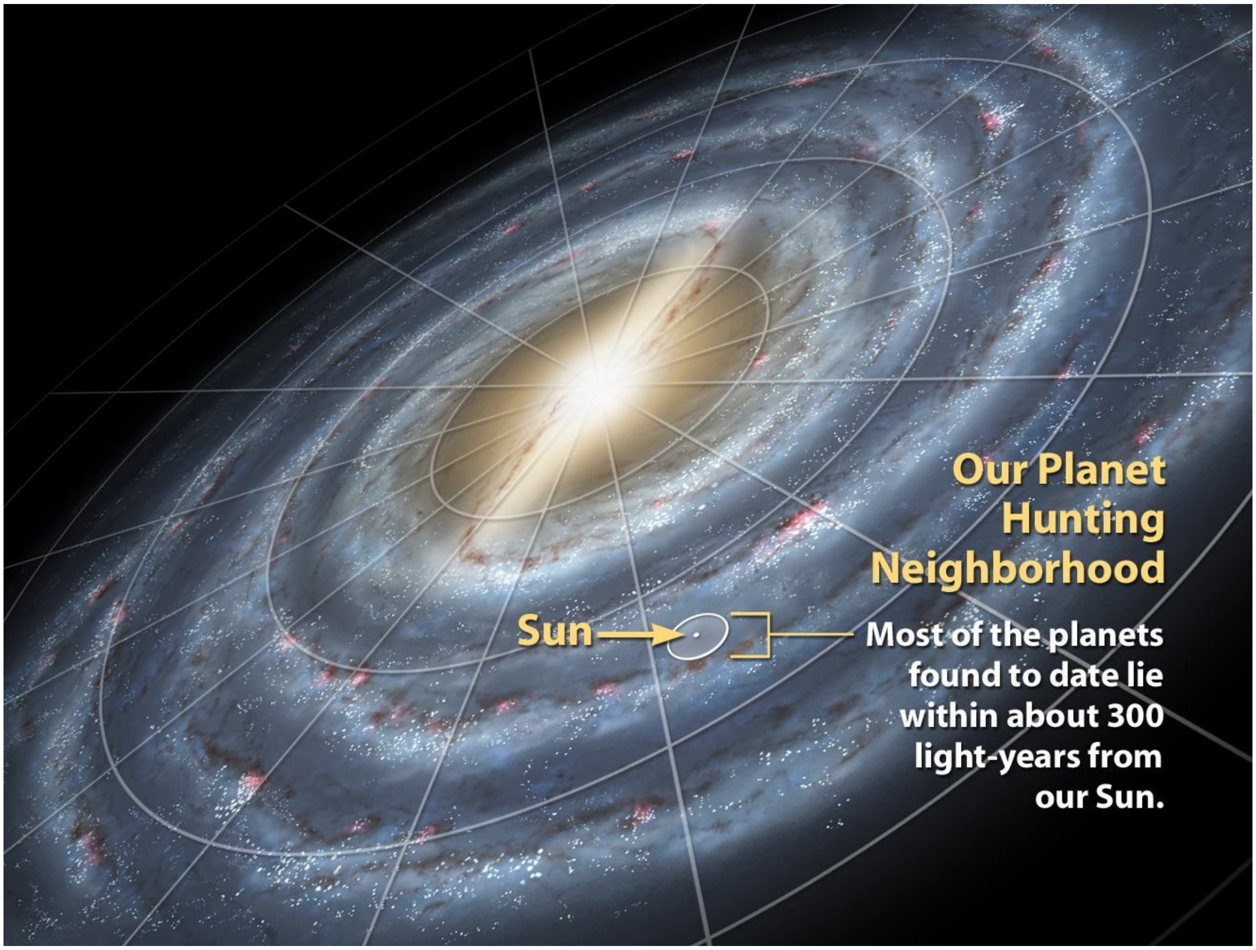
There are also several other features of the solar system, including asteroids, comets, and meteors. Most of them either originate from, or can be found in, the main asteroid belt between mars and Jupiter, the Kuiper belt (just beyond Neptune's orbit) or the Oort cloud (at the very edge of our solar system.



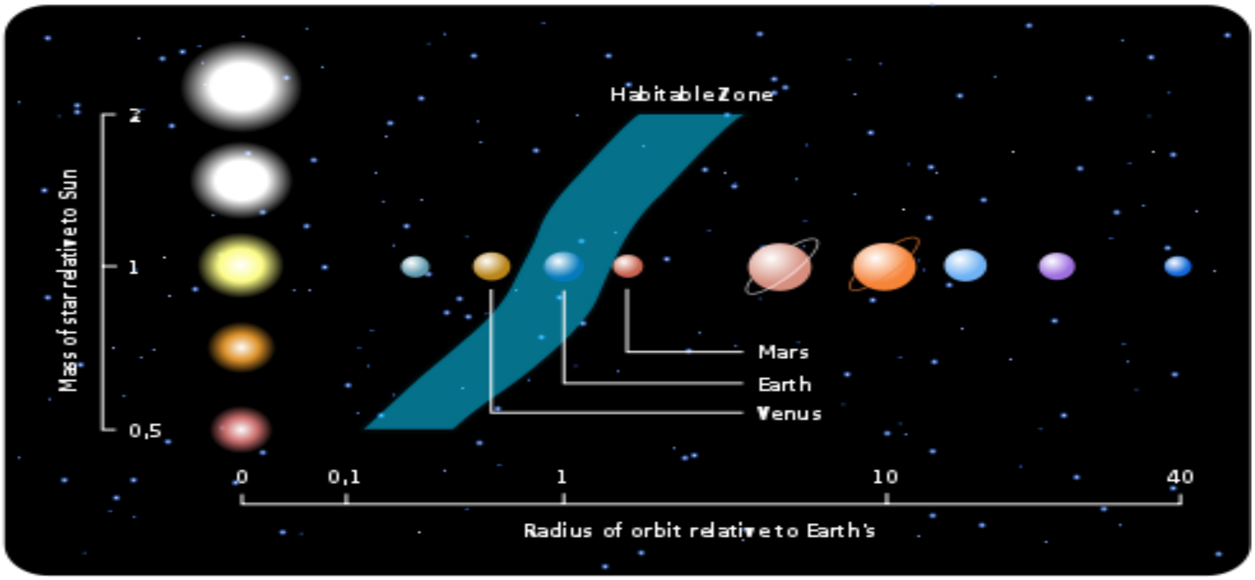
Please watch the following summary video for our solar system:
https://www.youtube.com/watch?v=libKVRa01L8

**The Earth – Sun Interaction System**

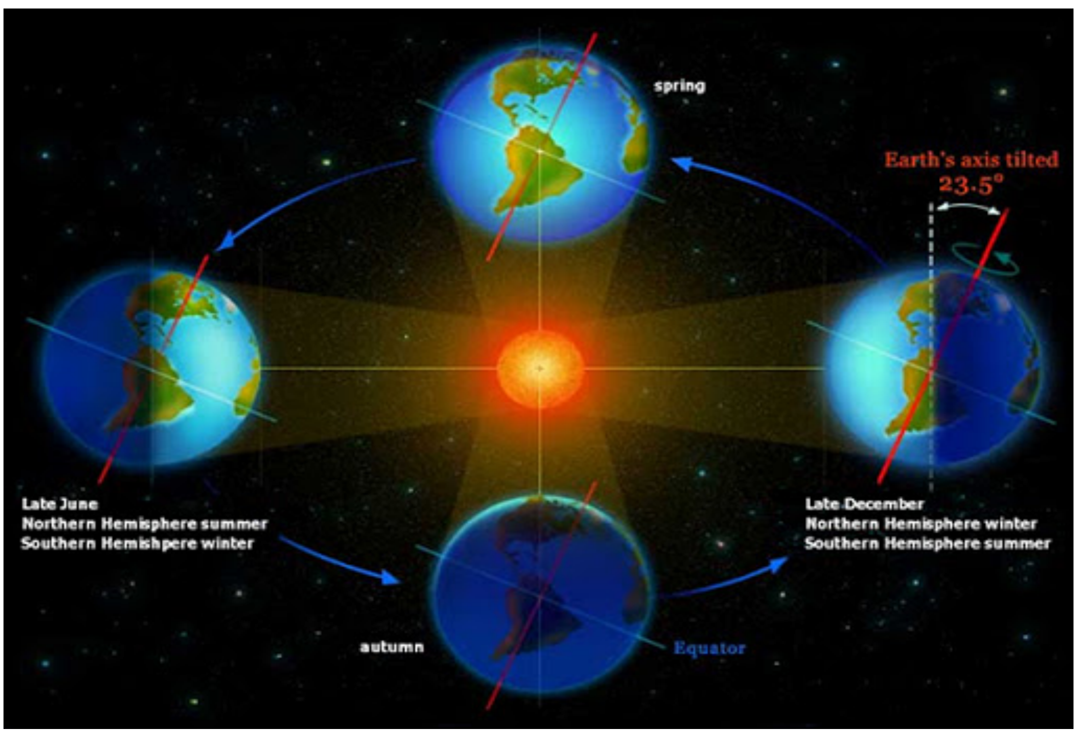
We live in a galaxy known as the Milky Way Galaxy. Specifically, our solar system resides on the Orion Arm of the Milky Way Galaxy as seen in the image below. We can also see that most of the new plants discovered in our galaxy are relatively close to us here on earth. Keep in mind that the Milky Way Galaxy has a diameter of 100,000 light years, and is mostly unexplored. But what makes the Earth so unique that it can harbour and sustain intelligent life?




The Earth is conveniently located at distance sometimes referred to as the goldilocks zone because water is able to exist in liquid form here. Too close to the sun and water will evaporate, while too far from the sun and water turns to ice. If the average temperature of a planet is "just right" it can retain water in liquid form, and have great potential for life to evolve. Earth is unique in this way, as no other planet in our solar system falls into the goldilocks zone (sometimes referred to as the habitable zone).




**In addition to our suitable distance from the earth, our planetary tilt and rotation around the sun is what provides the Earth with its seasons, and average night/day time durations.**




Check out the videos below that describes the habitable zone and the effects of earths tilt on the seasons:

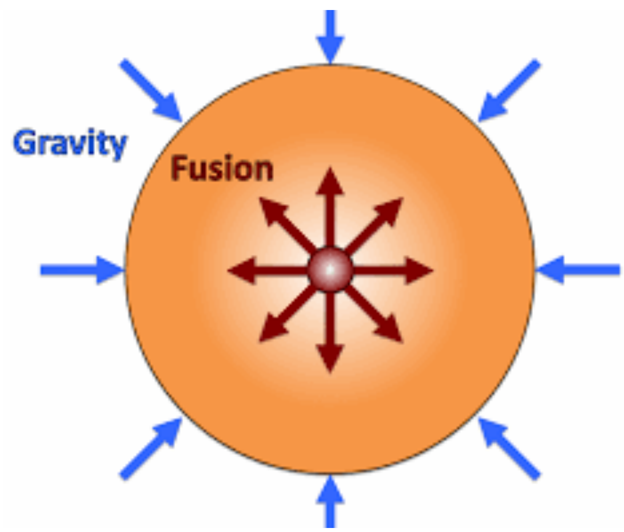
Habitable zone https ://www.youtube.com/watch?v=u2OlT9bECqg

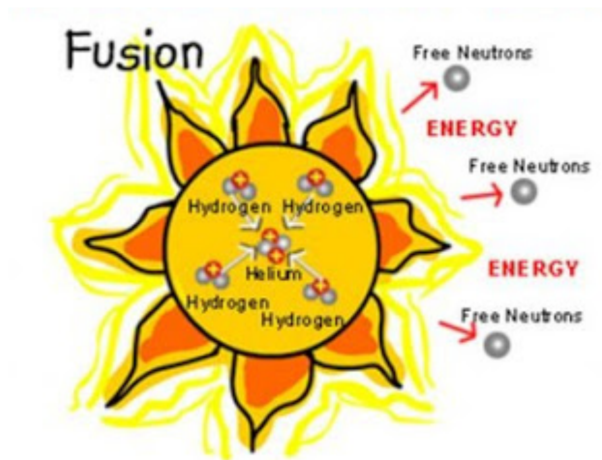
Earth's Seasons https://www.youtube.com/watch?v=WgHmqv_-Ub

Section 2: The Lifecycle of a Star

The sun in our solar system is known as a main sequence star. The sun's mass alone makes up 99.8% of all the mass in the entire solar system! For this reason, the sun has a high enough gravitational pull to keep all 8 planets within our solar system in orbit.

Within the sun's core, nuclear fusion takes place (at a staggering 15 million degrees Celsius!). Nuclear fusion is the process of joining atoms together to form brand new ones. In our sun, four hydrogen atoms are fused together to create helium. This process generates an immense amount of energy which is released as heat and radiation, which in turn heats the earth allowing for sustained life. It is this outward force of energy caused by nuclear fusion that is able to counter the inward pressure of gravity and prevents the sun from collapsing in on itself. If the sun ever ran out of hydrogen to fuel nuclear fusion, our star would collapse and explode in a supernova, taking the entire solar system with it. Not to worry though, best estimates made by scientists place that event 5-10 billion years from now.



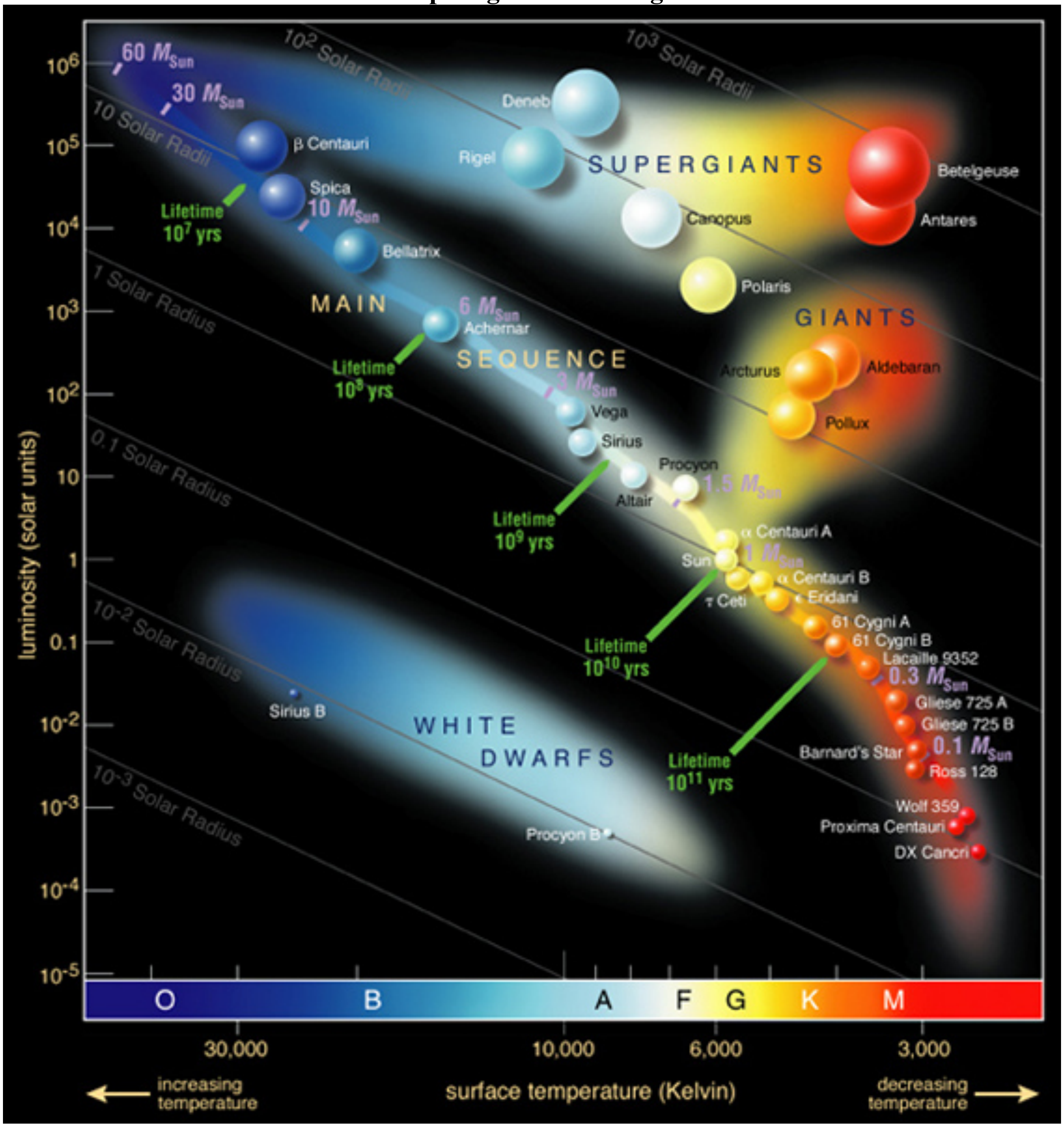

**Types of stars**

Stars are classified by their surface temperature and luminosity (their brightness). Both of these two factors also directly impact the resulting size of a star. All stars in the galaxy can be classified on what is called a Hertzsprung-Russel Diagram, or HR-Diagram for short.

Because we know our own sun the best, it gets a luminosity value of 1. However, many stars are much more luminous than our own sun and therefore have luminosity values higher than 1, while others are not as bright and receive a luminosity value less than 1. Typically, more luminous stars possess a much higher surface temperature, and are much larger in size.

Again, because we know our own sun the best, our sun gets a solar mass value of 1, while larger starts have a value higher than one, and smaller stars have a value less than 1. Check out the two diagrams for star classification below, we can see the four main types of stars: Supergiants, Giants, Main Sequence, and White Dwarves.

**Hertzsprung – Russel Diagram**



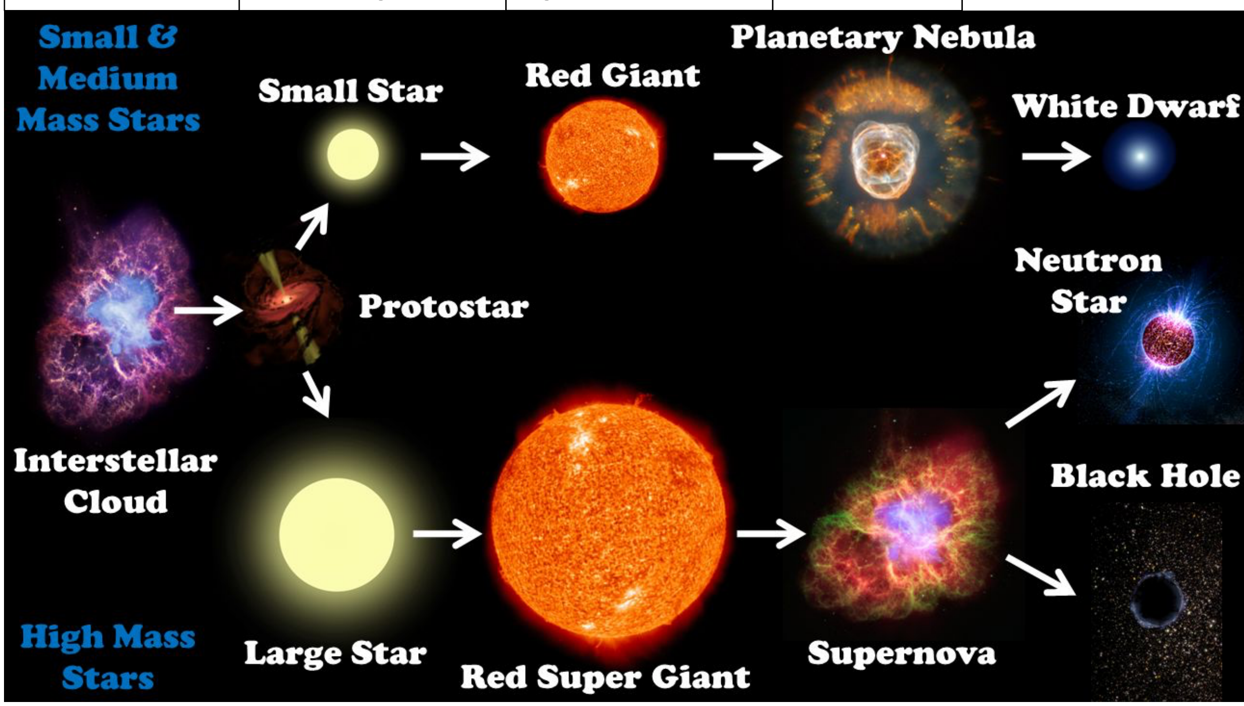

Based on the diagram, we can see that blue light corresponds to a hotter surface temperature, and red corresponds to a cooler surface temperature. We can also see that stars in the lower right-hand side of the diagram display older main sequence stars. This tells us that as stars age, they shrink in size, luminosity and surface temperature. This is due to the stars using up more and more of their available fuel sources for nuclear fusion.

Check out the video below on the classification of stars:
https://www.youtube.com/watch?v=ld75W1dz-h0

**The lifecycle of a star**

As stars use up all of their hydrogen during nuclear fusion, the stars become dimmer and dimmer, and gravity begins to push the star inwards shrinking the stars mass. Eventually, the pressure is so strong on the stars core that the temperature spikes extremely high under all of this pressure and the sun's core begins to fuse helium into carbon! At this point the star has a very high outward nuclear fusion force and it expands in size, becoming a giant star. This process repeats for a little bit until no more nuclear fusion can take place, and the star collapses for good. The diagram below traces the lifecycle of most stars.

| Birth of a star | Main Sequence – Middle age | Giant Stars – Old age | Star Death | Various outcomes depending on several factors |
| --- | --- | --- | --- | --- |




Check out the summary video on the lifecycle of stars!

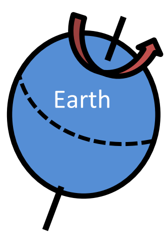
https://www.youtube.com/watch?v=4xIQGbYur9Q

# WORK SHEET 1
# SEASONS AND THE EARTHS ROTATION

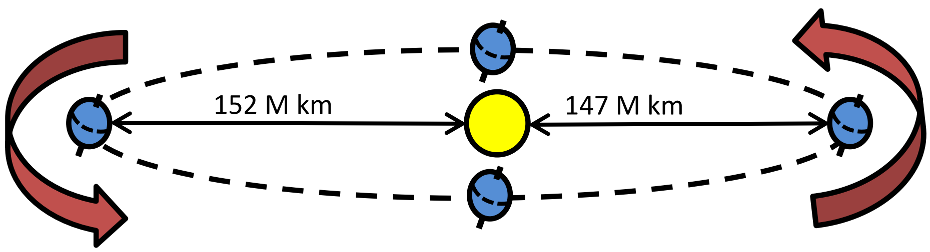
***TEK 8.7A: Model and illustrate how the tilted Earth rotates on its axis, causing day and night, and revolves around the Sun causing changes in seasons.***

The Earth spins, or rotates, on its axis once a day. This is the cause of the day—night cycle on Earth. In fact, the Earth's counter-clockwise rotation, not any motion of the Sun, is what makes the Sun seem to rise in the East and set in the West.

The Earth orbits, or revolves, around the Sun once in a year (365.25 days), also in a counter-clockwise direction, as viewed from over the North Pole. The shape of that orbit is almost a perfect circle, but is slightly "elliptical" (oval) in shape. The Earth is slightly closer to the Sun (147 million km) on about January 3rd each year, and slightly further away from the Sun (152 million km) on about July 4th each year. This 3% difference in the Earth to Sun distance during the year does NOT make any real difference in the temperature of our seasons.




ROTATION




REVOLUTION

The real cause of the seasons is the tilt of the Earth's axis, about 23.5 degrees. If the Earth's axis was not tilted, there would be no seasons on Earth—every day would be about the same temperature in any one place. Without tilt, every day and every place on Earth (except the poles) would have exactly 12 hours of daylight and 12 hours of night. It is the tilt that causes seasonal differences in the length of night and daylight—longer nights in winter and longer days in summer. It is the tilt that causes the Sun to be high in the sky in summer and low in the sky in winter. It is the combination of longer daylight hours and more direct sunlight that causes the heat of summer, and the combination of shorter daylight hours and less direct sunlight that causes the cold of winter.

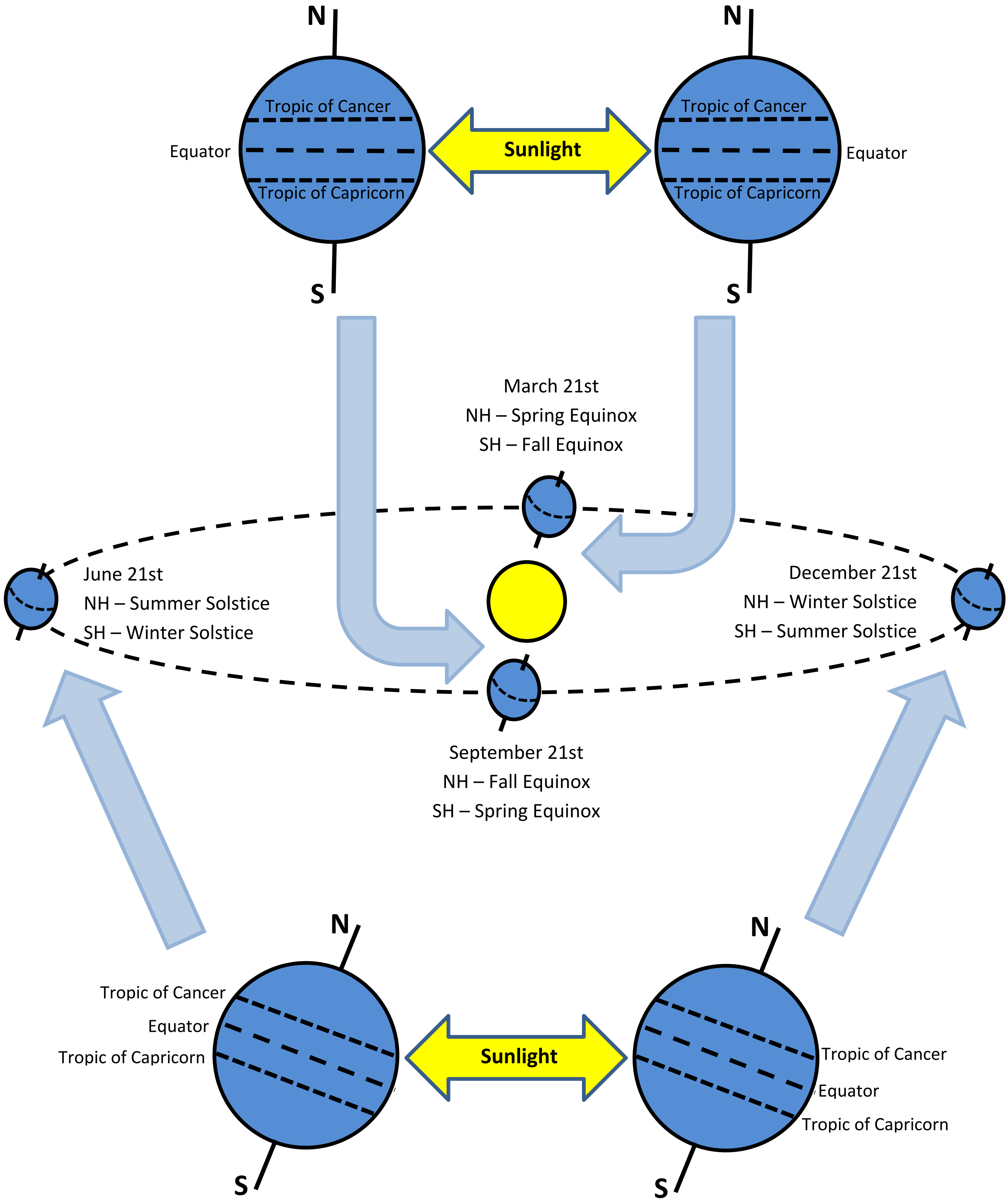
The angle of the Earth's tilt does not change during the year. The Earth's North Pole axis always points to Polaris, the North Star. But the hemisphere of Earth that faces the Sun more directly DOES change during the year, as the Earth orbits around the Sun. On one day a year (the summer solstice, June 21st), the northern hemisphere is tilted directly towards the Sun, and the Sun is directly overhead at the Tropic of Cancer, 23.5 degrees north latitude. Six months later (on the winter solstice, December 21st), the northern hemisphere is tilted directly away from the Sun, and the Sun is directly overhead at the Tropic of Capricorn, 23.5 degrees south latitude. On the two days halfway between those dates, both hemispheres face the Sun equally, the Sun is directly over the equator, and the length of day and night everywhere on Earth is exactly 12 hours each. These are called the spring (or "vernal") equinox (on March 21st in the northern hemisphere) and the fall (or "autumnal") equinox (on September 21st).

The seasons in the north and south hemispheres are the opposite of one another. In January, when it is winter in the northern hemisphere, it is summer in the summer hemisphere. In April, when it is spring in the northern hemisphere, it is fall in the southern hemisphere. In July, when it is summer in the northern hemisphere, it is winter in the southern hemisphere. In October, when it is fall in the northern hemisphere, it is spring in the southern hemisphere. Likewise, summer solstice in the northern hemisphere is the winter solstice in the southern hemisphere.

Between the Arctic Circle (66.5 degrees north latitude) and North Pole, and the Antarctic Circle (66.5 degrees south latitude) and South Pole, the apparent movement of the Sun across the sky daily and seasonally is different from the rest of Earth. At each pole, the Sun rises on the spring equinox and sets six months later on the fall equinox. Each 24 hour day during the summer, the Sun completely circles the horizon. At the Arctic or Antarctic Circles, the Sun does not set at all on one day, the summer solstice. In other words, on the summer solstice there is 24 hours of daylight and no night. Between 66.5 degrees latitude and the pole, the number of 24 hours days without a sunset increases as one moves towards the pole. In winter, the opposite occurs, with one or more 24 hour days with no sunrise, and 24 hours of darkness.

The greatest seasonal variation in daylight and night hours occurs at the North Pole and South Pole, and the lowest seasonal variation in daylight and night hours occurs in the tropics, between the Tropic of Cancer and Tropic of Capricorn, including the equator. In the tropics, the longest daylight period is 13 hours and shortest is 11 hours. In Dallas, the longest daylight period is about 14.5 hours and the shortest 9.5 hours. In southern Alaska, the longest daylight period is 19 hours, and shortest 5 hours.

The diagram on the next page shows an angled view down on the Earth's orbit, with the Sun in the center. (The shape of the orbit is not really this elliptical (oval)—the low angle of view needed to show the tilt in each season just makes it seem elliptical.) A close-up of the Earth in each position shows the latitude where the Sun's light is directly overhead. (A side view of Earth at the two equinox positions is used to show the angle of sunlight falling on Earth.) The solstice or equinox at each location is noted, as well as the season starting at that position and date.


N
N
Tropic of Cancer
Equator
Tropic of Capricorn
Sunlight
Tropic of Cancer
Equator
Tropic of Capricorn
S
S
March 21st
NH – Spring Equinox
SH – Fall Equinox
June 21st
NH – Summer Solstice
SH – Winter Solstice
December 21st
NH – Winter Solstice
SH – Summer Solstice
September 21st
NH – Fall Equinox
SH – Spring Equinox
N
N
Tropic of Cancer
Equator
Tropic of Capricorn
Sunlight
Tropic of Cancer
Equator
Tropic of Capricorn
S
S

1. The day and night cycle on Earth is caused by the Earth's _____________ or r_________________ on its axis.
2. The yearly cycle of seasons on Earth are caused by the ___________ of the Earth's axis and the _____________ or r__________________ of the Earth around the Sun.
3. On January 3rd of each year, the Earth is _________________ **(closest / farthest)** from the Sun, _______ million kilometers.
4. On July 4th of each year, the Earth is __________________ **(closest / farthest)** from the Sun, ________ million kilometers.
5. The varying distance from the Sun to the Earth ____________ **(is / is not)** the reason for the seasons.
6. On about December 21st, the _______________ hemisphere is tilted directly towards the Sun, and it is their _________________ solstice.
7. On about December 21st, the _________________ hemisphere is tilted directly away from the Sun, and it is their _____________________ solstice.
8. On about December 21st, the Sun is directly overhead at the Tropic of _______________, 23.5 degrees ____________ latitude.
9. On about March 21st, the Sun is directly overhead at the _________________, 0 degrees latitude, and it is the __________________ equinox in the northern hemisphere and the _______________ equinox in the southern hemisphere. On this day, there are _____ hours of daylight and _____ hours of night everywhere on Earth.
10. On about June 21st, the _______________ hemisphere is tilted directly towards the Sun, and it is their _________________ solstice.
11. On about June 21st, the _________________ hemisphere is tilted directly away from the Sun, and it is their _____________________ solstice.
12. On about June 21st, the Sun is directly overhead at the Tropic of _______________, 23.5 degrees ____________ latitude.
13. On about September 21st, the Sun is directly overhead at the _________________, 0 degrees latitude, and it is the __________________ equinox in the northern hemisphere and the _______________ equinox in the southern hemisphere. On

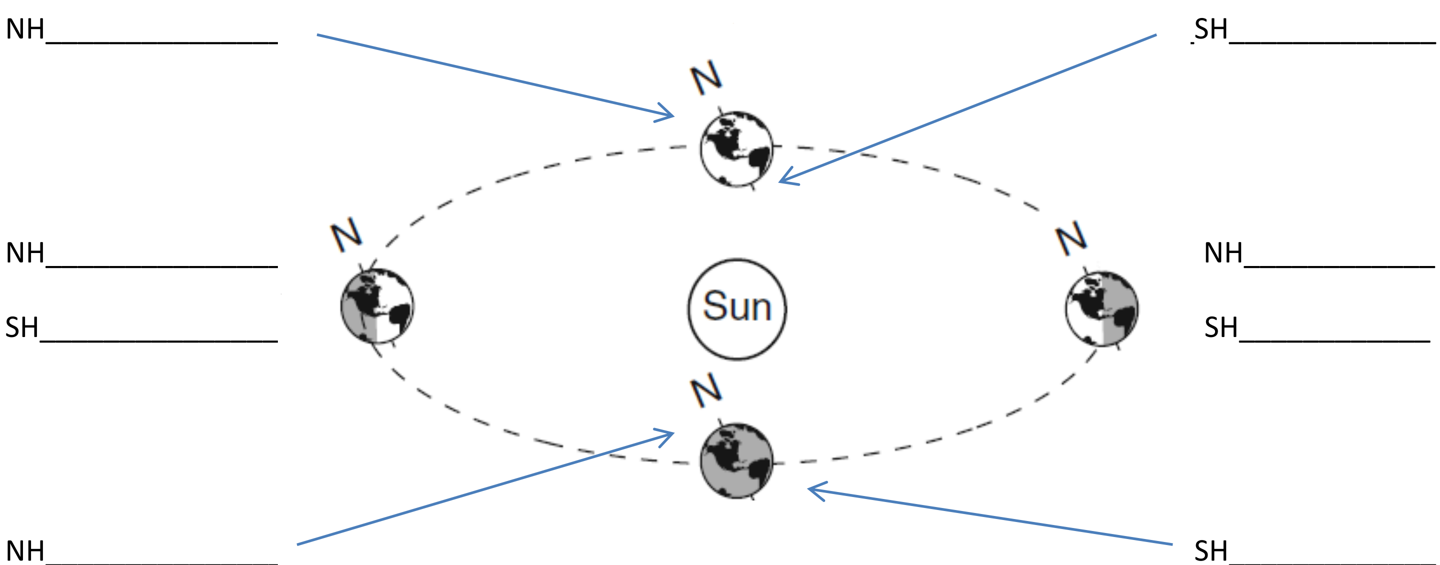
this day, there are ______ hours of daylight and ______ hours of night everywhere on Earth.

14. The Sun is highest in the sky during the _____________ season, and lowest in the sky during the ________________ season.

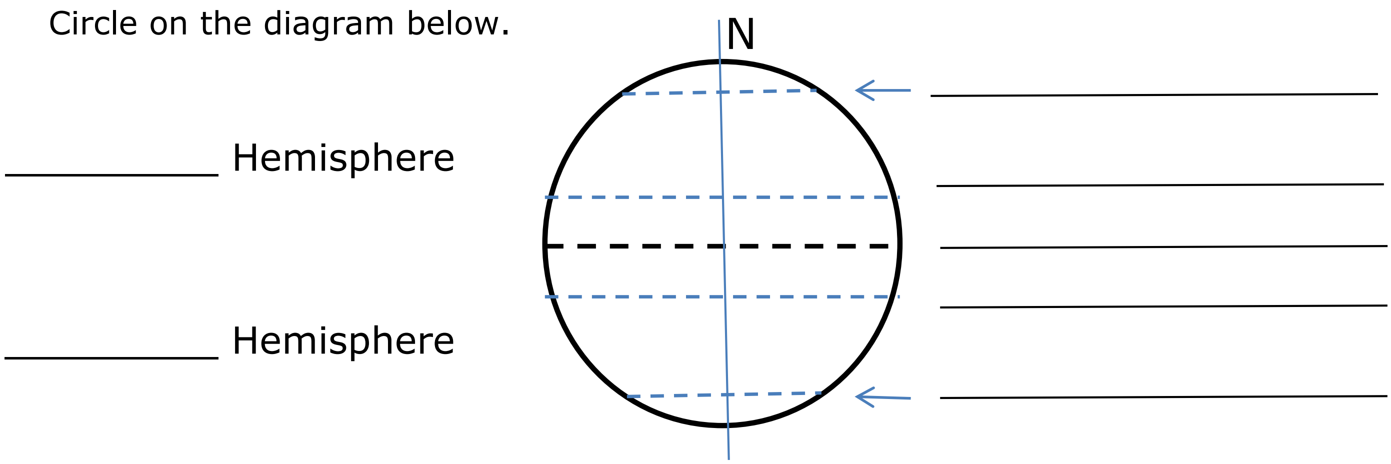
15. The number of daylight hours is the greatest during the ___________________ season, and the lowest during the ____________________ season.

16. The greatest seasonal variation in daylight and night hours occurs at the ___________________ and ____________________, and the lowest seasonal variation in daylight and night hours occurs at the ______________________.

17. In the diagram below, label the position of Earth at the start of each season for each hemisphere, in the blanks provided. (NH = northern hemisphere; SH = southern hemisphere) Also label with arrows the direction of Earth's spin (rotation) and orbit (revolution). Note that this diagram has a different viewpoint than the one in the explanatory text above—it is shown from the opposite side, reversing the direction of the Earth's tilt.




18. Label the Equator, Tropic of Cancer, Tropic of Capricorn, Arctic Circle and Antarctic Circle on the diagram below.

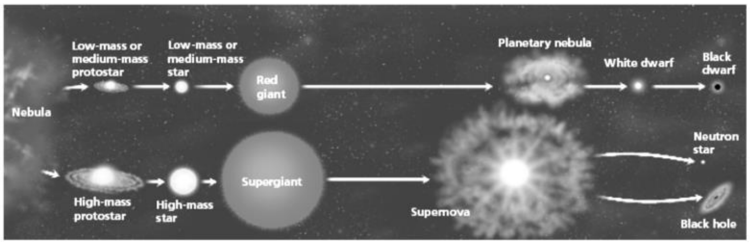


# WORKSHEET 2
# THE LIFECYCLE OF A STAR

Name: _______________

**A STAR IS BORN – STAGES COMMON TO ALL STARS**

All stars start as a **nebula.** **A nebula** is a large cloud of gas and dust. Gravity can pull some of the gas and dust in a nebula together. The contracting cloud is then called a **protostar.** A protostar is the earliest stage of a star's life. **A star is born when the gas and dust from a nebula become so hot that nuclear fusion starts.** Once a star has "turned on" it is known as **a main sequence star**. When a main sequence star begins to run out of hydrogen fuel, the star becomes a **red giant** o **red super giant.**

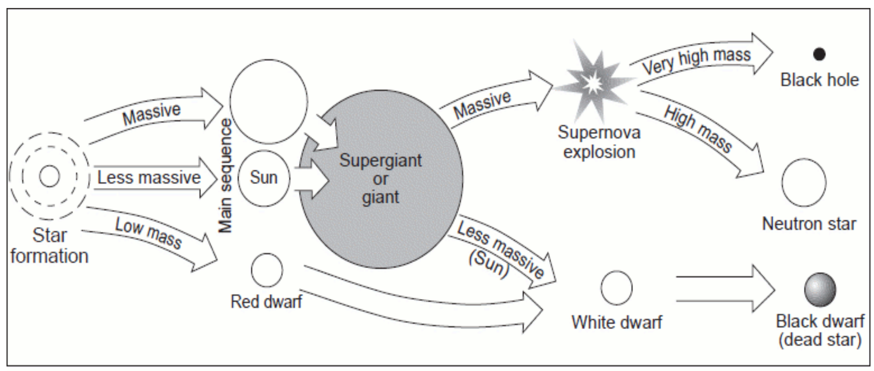



**THE DEATH OF A LOW OR MEDIUM MASS STAR**

After a low or medium mass or star has become a red giant the outer parts grow bigger and drift into space, forming a cloud of gas called a **planetary nebula**. The blue-white hot core of the star that is left behind cools and becomes a **white dwarf.** The white dwarf eventually runs out of fuel and dies as a **black dwarf.**

**THE DEATH OF A HIGH MASS STAR**

A dying red super giant star can suddenly explode. The explosion is called a **supernova.** After the star explodes, some of the materials from the star are left behind. This material may form a neutron star. **Neutron stars** are the remains of high-mass stars. The most massive stars become **black holes** when they die. After a large mass star explodes, a large amount of mass may remain. The gravity of the mass is so strong that gas is pulled inward, pulling more gas into a smaller and smaller space. Eventually, the gravity becomes so strong that nothing can escape, not even light.




(Not drawn to scale)

**Section One - Sequencing**

The stages below are not in the right order. Number the stages in the correct order.

_____ The star begins to run out of fuel and expands into a **red giant** or **red super giant**.

_____ Stars start out as diffused clouds of gas and dust drifting through space. A single one of these clouds is called a **nebula**

_____ What happens next depends on the mass of the star.

_____ Heat and pressure build in the core of the **protostar** until **nuclear fusion** takes place.

_____ The force of gravity pulls a nebula together forming clumps called **protostars**.

_____ Hydrogen atoms are fused together generating an enormous amount of energy igniting the star causing it to shine.

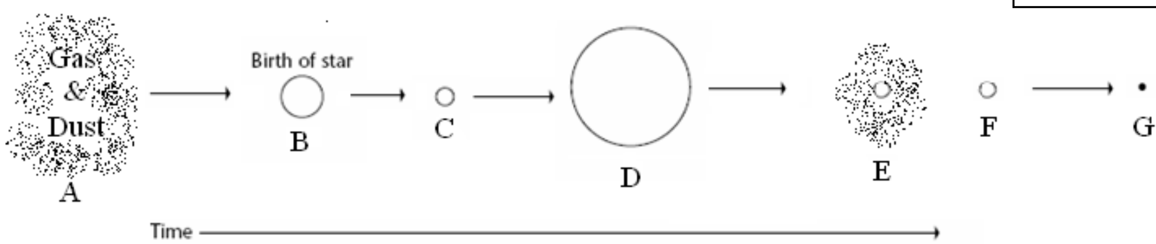
**Section Two - Vocabulary**

Match the word on the left with the definition on the right.

| | |
|---|---|
| ____ **black dwarf** | **e.** star left at the core of a planetary nebula |
| ____ **white dwarf** | **g.** a red super giant star explodes |
| ____ **nebula** | **c.** what a medium-mass star becomes at the end of its life |
| ____ **protostar** | **b.** a large cloud of gas or dust in space |
| ____ **supernova** | **a.** exerts such a strong gravitational pull that no light escapes |
| ____ **neutron star** | **d.** the earliest stage of a star 's life |
| ____ **black hole** | **f.** the remains of a high mass star |

Label the diagram with all the words given as well as write down the Letter that matches each object.

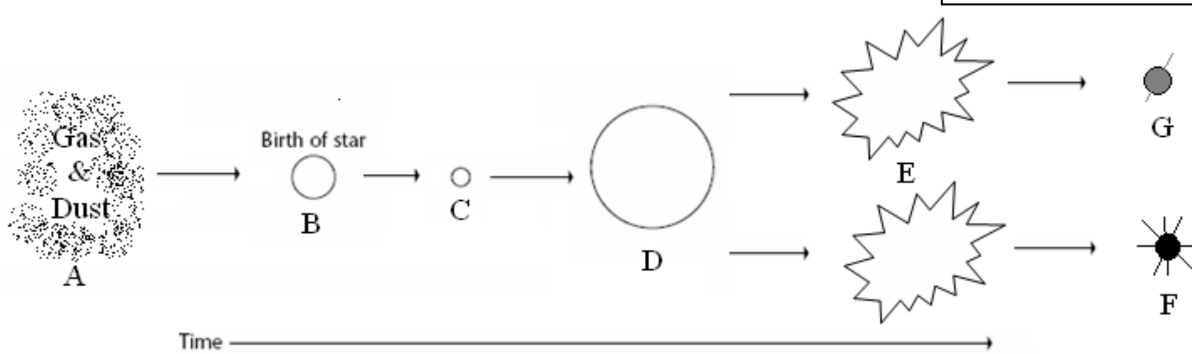
**Section Three – Understanding Main Ideas - Low Mass Star**




____ **1.** Red giant
____ **2.** Where fusion begins
____ **3.** Nebula
____ **4.** Black dwarf
____ **5.** The stage the sun is in
____ **6.** White dwarf
____ **7**. Planetary Nebula

Label the diagram with all the words given as well as write down the Letter that matches each object.

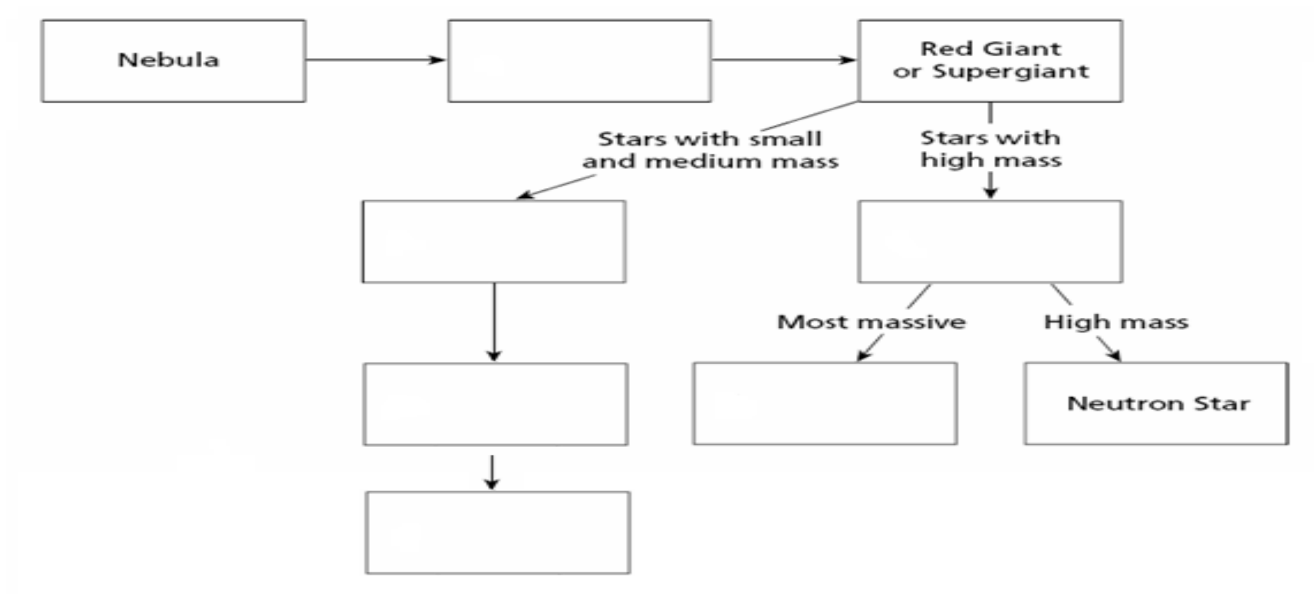
**Section Four – Understanding Main Ideas - High Mass Star**




____ **1.** Black Hole ____ **2**. Supernova ____ **3**. Protostar
____ **4.** Gravity causes this to condense into a protostar ____ **5**. Main sequence star
____ **6**. When a star begins to run out of fuel and grows larger
____ **7**. Neutron star

**Section Five – Graphic Organizer – Putting it all Together**

Black hole    Supernova    White dwarf    Planetary nebula    Protostar    Black dwarf




**Section Six –** Use the following words to fill in the blanks

Black hole    Massive    White dwarf    Supernova    Average    Nebulae
Super-giant    Neutron star

1. ___________________ are clouds of dust and gas from which a star first forms. They are pulled together by gravity into a spinning disc. The center of the disc becomes a star while the rest can become a system of planets.

2. ____________________ come from giant or massive stars. They grow to as much as three times the mass of our sun as they lose the nuclear fuel at their core. The outer layer of this red star expands as the core on tracts.

3. Nebula can form either an ________________ star that is about the size of our Sun or a _____________ star which can be over three times as big as our Sun! These stars stay in this period for most of their lives and they convert hydrogen to helium while generating lots of heat and light.

4. At the end of the life of a giant star, a ________________ is resulted when a red supergiant's core collapses in on itself. The electrical forces at the center of the star overcome the gravitational pull and create a massive explosion that scatters the outer layers of the red supergiant.

5. The outer layers of a red giant keep expanding until they eventually drift off and form a ______ __________.

6. Eventually the outer layers of an average star drift away and the star becomes a much smaller ________________ _______. It has now run out of nuclear fuel to burn off.

**7.** If the star is very massive or big enough, a __________ _______ is formed, which is so dense that not even light can escape its gravitational pull!

**Using the word list, fill in the blanks in the paragraphs below.**

**fuel, nebula, expanding, less, hydrogen, smaller, energy, Sun, quickest, supernova, homes, white, neutron, giants, helium, Big Bang, billions**

The Universe is believed to have been formed from a very dense fireball _____________ of years ago. As the fireball expanded and cooled stars and galaxies formed. The fireball explosion is often called the ___ ________. The explosion threw all the material outwards; that is why scientists believe the universe is getting bigger or ____________. Scientists have confirmed that the Universe is expanding by examining the light given off by stars. Astronomers now know that the distance to the furthest galaxies is becoming greater as these galaxies are moving away the __________. Stars are produced from gas clouds or ___________, which contain mainly the element ____________. The type of star produced depends on the mass of the star. Red _________ are stars formed which have a mass _________ than that of our ____________ .

Hydrogen is the __________ of all stars. During nuclear fusion the hydrogen molecules combine producing ____________, releasing lots of ____________ in the process. How quickly the hydrogen is used up depends on the size of the star. Massive stars burn hydrogen very quickly. Additional nuclear fusion reactions can convert helium into elements with larger atoms, for example lithium. However the elements with the largest atoms only form when a star explodes as a _______________

The amount of energy given out by a star, its luminosity, varies considerably. ____________ dwarfs are stars that have a very low luminosity, about one hundredth of the Sun. Super giant stars which are very large red giant stars, can give out as much energy as 1,000,000 Suns. Some scientists believe that our Solar System was once a binary star system. The Sun was the __________ of the two stars and burnt its fuel slowly, lasting millions of years. The larger star used up all its fuel and destroyed itself in a supernova explosion, leaving the Sun behind.

The Sun is a very stable star. In a few billion years from now the Sun will use up its fuel supply and start to change. It will probably expand and form a red giant. Finally, it may form a white dwarf or a ____________ star. When this happens there will no longer be life on the Earth, but by then we should have found new _________ around other stars.