LAYERS OF THE SUN Reading

The Sun and the Solar System

The **sun** and its **solar system** formed around 4.6 billion years ago in the **Milky Way Galaxy**. The sun formed from a **nebula**- a cloud of gas and dust where young stars are born. As gravity pulled the nebula's particles together, they began to collide and stick, forming larger and larger objects. Eventually, these objects grew into the sun, and the planets, dwarf planets, moons, asteroids, and comets that make up our solar system. The majority of the mass in the solar system is concentrated in the sun; it contains more than 99% of the total mass of the entire system. The sun is the center of the solar system and its gravitational pull extends far beyond the orbit of Pluto to the distant Oort Cloud.

The sun is a **star**- a burning ball of gasses and plasma. **Plasma** is one of the four states of matter; it is an ionized gas consisting of charged particles at extremely hot temperatures. Our sun is classified as a **yellow dwarf star** and is about 333,000 times more massive than the Earth and about 93 million miles away. It is primarily composed of **hydrogen** (~91%) and **helium** (~8.9%), with small amounts of other elements. Its energy is produced by nuclear fusion reactions in the core, where temperatures can reach 15 million degrees Celsius! **Nuclear fusion** is the process of combining two atomic nuclei (hydrogen) to form a heavier nucleus (helium), and releasing a huge amount of energy. The sun's energy output is what powers life on Earth and drives the Earth's weather and ocean currents. The sun's energy is essential for life on Earth, providing heat, light, and energy for photosynthesis.

The Sun's Layers

The outermost layer of the sun is called the **corona**. It's a thin, wispy layer that extends millions of miles into space. Beneath the corona lies the **chromosphere**, a layer of hot, glowing gases that extends about 1,500 miles above the sun's surface. The corona and the chromosphere are best seen during a total solar eclipse, when the moon blocks out the bright light of the sun's surface. Below the chromosphere is the **photosphere**, the visible surface of the sun that emits light and heat. The photosphere is about 300 miles thick and has a temperature of about 10,000 degrees Fahrenheit. Together these three layers make up the **solar atmosphere**. **Sunspots** are dark areas that appear on the photosphere of the sun. They are caused by the sun's magnetic field, which can cause a decrease in temperature and result in a lower amount of light being emitted in these spots. The spots can vary in size and shape, and can last a few days or several weeks. **Solar prominences** are large, bright features that extend out from the sun's surface. They are also caused by the magnetic field of the sun, which can cause gas and plasma to rise up from the sun's surface. Solar prominences can be seen during a total solar eclipse or by using specialized telescopes. Sunspots and solar flares can affect Earth's magnetic field and cause disruptions in our power grids. Below the photosphere are the **convective zone** and then the **radiative zone**- named for the type of heat transfer that occurs in each. Radiation is the transfer of heat through electromagnetic waves and convection is the transfer of heat through the movement of fluids (liquids, gases, or plasma). Finally, at the **core** of the sun lies a dense, hot region where nuclear fusion occurs, releasing visible and other types of light energy.

Our sun is on **the main sequence**- it is an average-sized star in the middle of its life cycle. It is in a state of equilibrium, with energy produced by nuclear fusion in the core balancing the gravitational forces that pull it inward. In about 5 billion years, the sun will begin to run out of fuel in its core. This process leads to the star expanding outward, becoming a cooler, larger **red giant**. Eventually, gravity will take over, causing the star to collapse in on itself, becoming a small, dim star called a white dwarf.

LAYERS OF THE SUN Vocab Questions

1 What bodies make up our solar system?

2 Match each definition with the letter of the correct vocabulary term.

1.) The visible surface of the sun: ___
2.)2 atomic nuclei merge under extreme heat & pressure: ___
3.)The hottest layer of the sun- nuclear fusion occurs here:___
4.) The product of nuclear fusion in the sun: ___
5.) An expanded, dying star with a cooled outer layer: ___
6.) Bright celestial object held together by its own gravity:___
7.) Clouds of gas and dust in space where stars are born: ___
8.)Dim sun-surface patches caused by the magnetic field___
9.) The fuel for nuclear fusion in the sun: ___
10.) Heated plasma is less dense & rises in this layer: ___
11.) The outermost layer of the sun's atmosphere: ___
12.)Waves of energy from the core move through this layer:___
13.) The second layer of the sun's glowing atmosphere: ___
14.) The 4th state of matter- not a solid, liquid, or gas: ___
15.) Average stars in the most stable part of their lifespan: ___

VOCABULARY
A.) Helium
B.) Star
C.) Corona
D.) Nebula
E.) Photosphere
F.) Yellow Dwarf Star
G.) Chromosphere
H.) Sun Spots
I.) Nuclear Fusion
J.) Radiative Zone
K.) Plasma
L.) Red Giant Star
M.) Hydrogen
N.) Convective Zone
O.) Core

3 Describe at least three ways that life wouldn't be possible on Earth without the sun.

LAYERS OF THE SUN *Reading Questions*

1.) How did the sun and the solar system form?

2.) How far does the sun's gravity extend?

3.) What elements make up the sun and in what percentages?

4.) What is the difference between gas and plasma?

5.) What is nuclear fusion? In what layer of the sun does nuclear fusion occur?

6.) Briefly describe each layer of the sun:

Corona- _____

_____- _____

_____- _____

_____- _____

_____- _____

Core- _____

LAYERS OF THE SUN *Reading Questions*

7.) How hot is the sun's core? How is heat transferred from the core to the photosphere?

8.) What will happen with the sun in 5 billion years?

9.) What do we mean when we say the sun is a main sequence star?

10.) For each of the following examples, decide if they are examples of convection or radiation:

- Blobs of wax rise and fall in a lava lamp: _____
- A heat lamp keeps a plate of food warm at a restaurant: _____
- Your friend gets a sunburn at the beach: _____
- A pot of soup boils on the stove: _____
- A cold-blooded lizard basks in the sun on a rock: _____
- A hot air balloon rises in the atmosphere: _____
- The top layer of a pool is the warmest: _____
- Rays of light reach your desk from the window: _____
- X-rays travel through space at the speed of light: _____

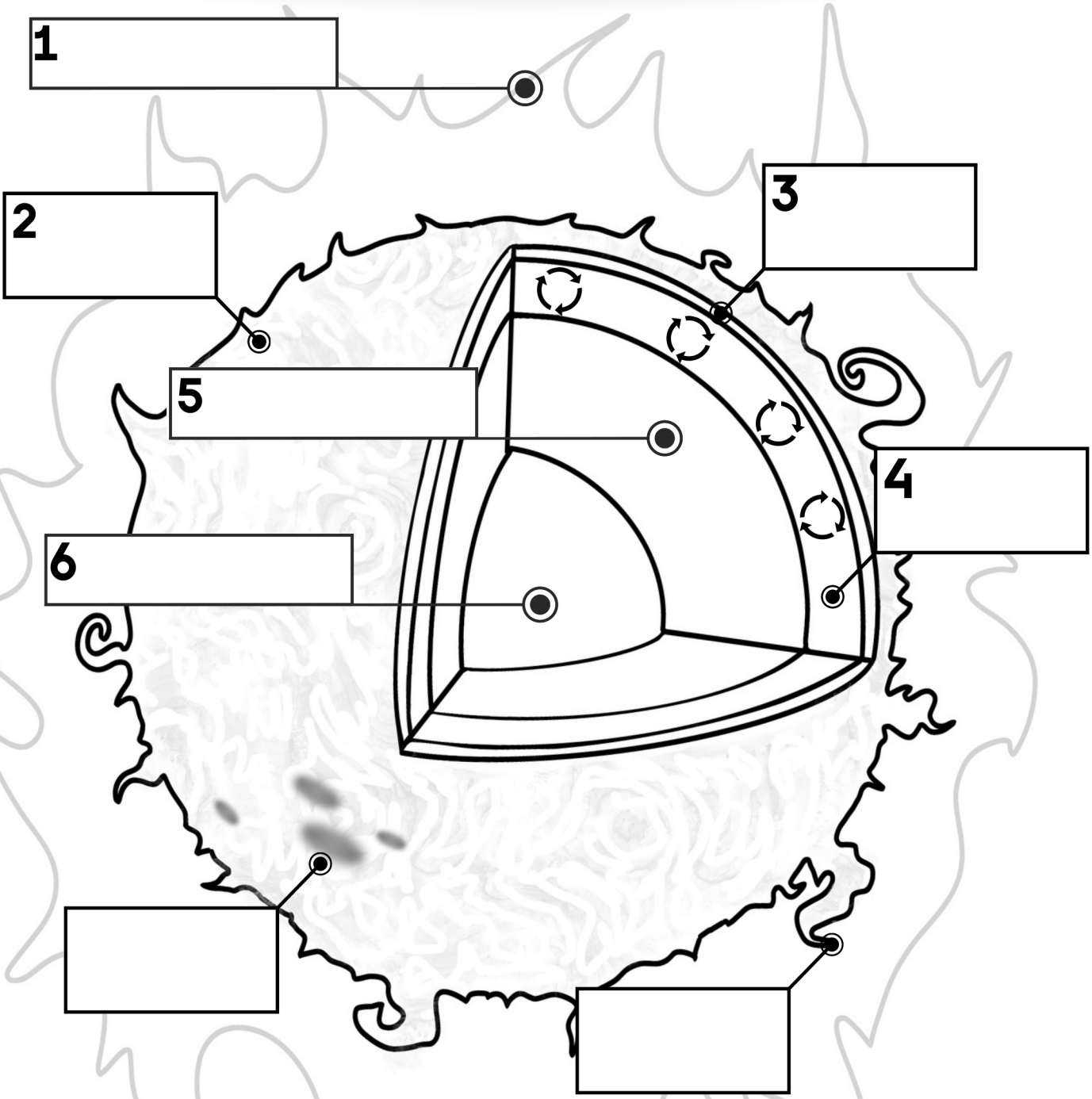
11.) Compare and contrast sunspots and solar prominences in the diagram below.

Sunspots	**Both**	**Solar Prominences**

Name: Date:

Sun's Layers Color

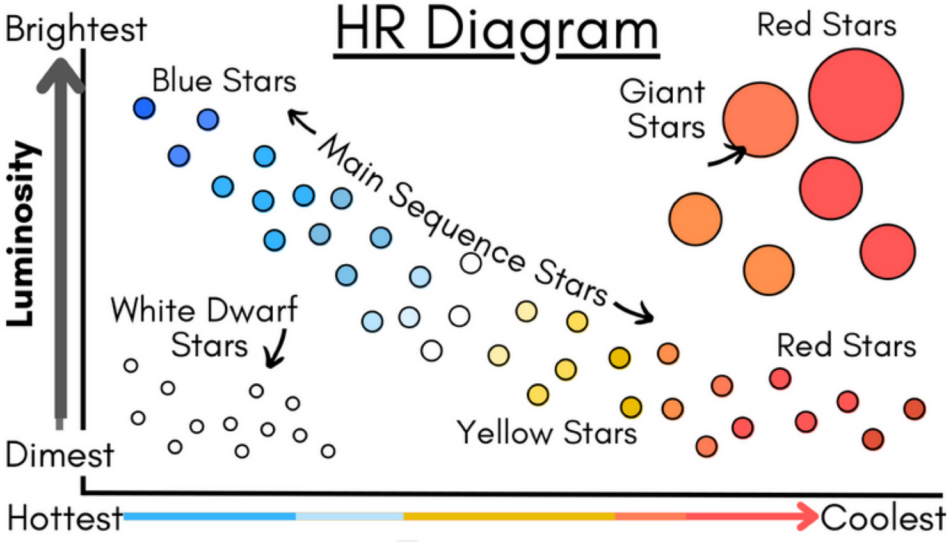
Label the numbered layers of the sun & the two solar features. Color in the core bright yellow, the corona light red-pink, the photosphere red, the radiative zone orange, the convective zone red-orange, & the chromosphere orange.



LAYERS OF THE SUN *Extension*

Read about HR Diagrams and use the diagram to answer the questions that follow.

Stars can be different sizes and have different temperatures. The **Hertzsprung-Russell (HR)** diagram is a graph that plots stars according to their luminosity and temperature. **Luminosity** is the measured brightness of a star. We measure luminosity in the unit L⊙, which is the luminosity of our sun. Our sun is an average-sized yellow dwarf star. So if a star has a luminosity of one, it has the same brightness as our sun. How bright a star is depends on its **size and temperature**. **Stars that are bigger are brighter** than smaller stars (if they have the same temperature). Stars that are **hotter are brighter** than cooler stars (if the same size).



1.) Draw a square on the HR Diagram where our sun would be found.

2.) When our sun becomes a red giant star, will each of these factors increase or decrease?

Size:_____ Luminocity:_____ & Temperature:_____

3.) What color star is the hottest? _____

4.) Why are red giant stars the same luminosity as blue dwarf stars?

5.) What two kinds of stars are the dimmest? _____

6.) How does temperature impact luminosity?

7.) How does size impact luminosity?