Understanding the H-R Diagram Lesson and Assignment

Introduction:

Stars are classified according to their brightness and temperature. They range in temperature from super hot blue-white stars (over 20,000°C) to cool red stars (2,500°C + to 3,000°C). Look at the chart below and you will see that our Sun is a medium yellow star.

A *star's color* is determined by its *temperature.* Red stars are cooler and blue stars are hotter. "The temperature of a star is determined by the mass it had when it formed and by its evolutionary stage (its "growth" stage). In general, the more massive a star is, the hottest its surface." [1]

In other words, how hot, how luminous and which stages a star will go through and eventually become (its life span) is dependent upon the star's *original mass* at the time of formation.

"The Hertzsprung -Russell (H-R) Diagram is a graph that plots stars color (spectral type or surface temperature) vs. its luminosity (intrinsic brightness or absolute magnitude)." [2]

Most stars fall into the Main Sequence range, including our sun. They are stable and remain at this stage for about 5 billion years. However, when stars begin to die they become giants and supergiants and they have used up their supply of hydrogen used in the process of nuclear fusion. The core of the star will contract while their outermost layers expand. Then the star will eventually explode into a supernova. The final stage of a star's life will be that of a dwarf or black hole, depending upon the star's original mass at its time of formation.

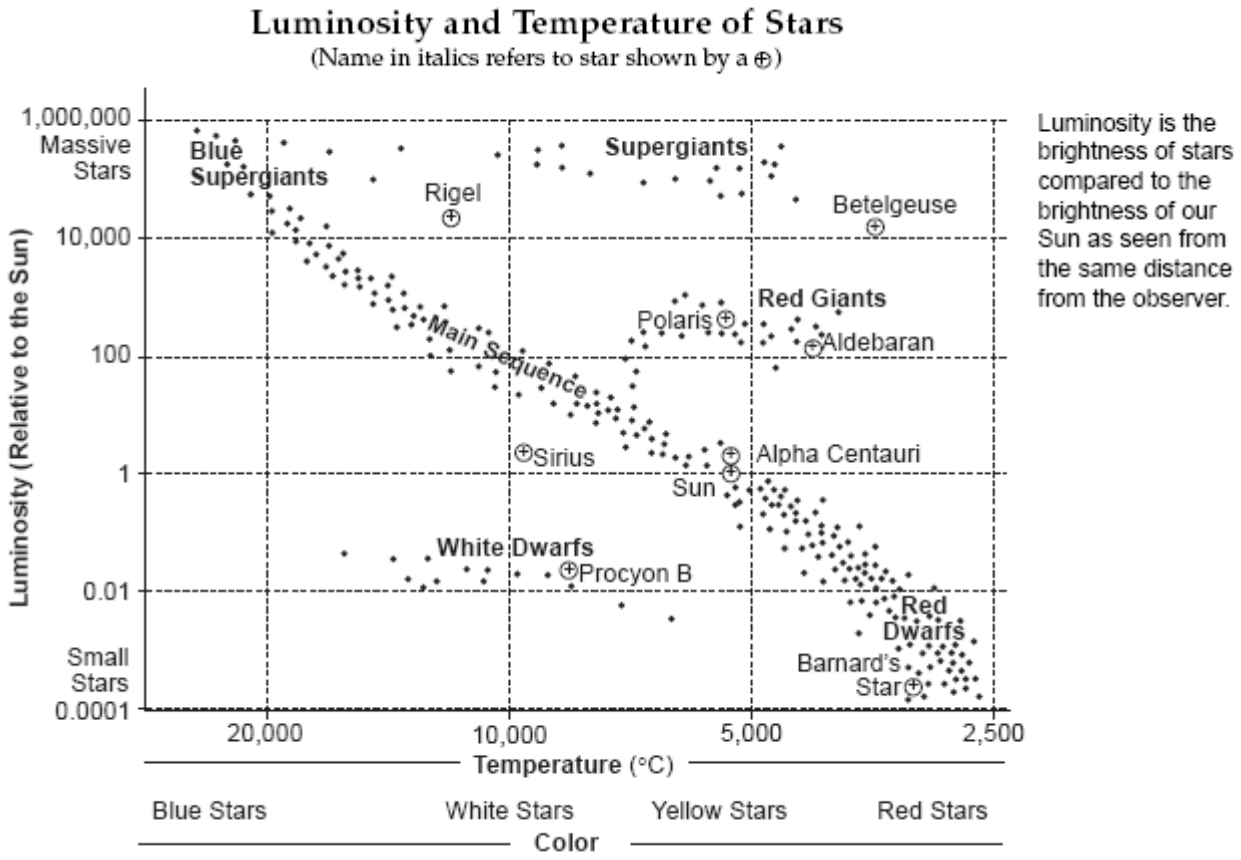
In order to complete the accompanying assignment for this lesson, you must first learn about luminosity and the types of stars you will see on the H-R Diagram. (Here is a web page that will provide additional information about the *Hertzsprung - Russell Diagram*.)

On page 2 there is a copy of the New York State Earth Science Reference Tables HR Diagram.
Specific stars and concepts on the diagram have been defined on pages 3 and 4.

They are:

Luminosity	Red Giants
Main Sequence	Blue Giants
Sun	Red Dwarfs
Polaris	White Dwarfs
Supergiants	

All definitions are courtesy of: Zoom Astronomy Glossary.



Luminosity and Temperature of Stars, H-R Diagram is courtesy of:
New York State Earth Science Reference Tables 2001 Edition.

STAR LUMINOSITY

You will find the definition of Luminosity at the upper right hand corner of the H-R Diagram on page 2.

Clearly, luminosity refers to "brightness".

The scale of luminosity on the H-R Diagram is specifically referring to brightness of *other stars* when compared to *our own Sun*.

To illustrate, here is an example (though not drawn nor colored to scale) of 2 stars compared to our Sun.

MAIN SEQUENCE STARS

"Main sequence stars are the central band of stars on the Hertzsprung-Russell Diagram. These stars' energy comes from nuclear fusion, as they convert Hydrogen to Helium. Most stars are Main Sequence Stars. For these stars, the hotter they are the brighter. The sun is a typical Main Sequence star."

THE SUN

"The Sun is a star at the center of our solar system. Our Sun is a medium-sized yellow star that is 93,026,724 miles (149,680,000 km) from Earth. Its diameter is 865,121 miles (1,391,980 km). At its core, nuclear reactions produce enormous amounts of energy, through the process of converting hydrogen atoms into helium atoms (nuclear fusion). Its absolute magnitude is +4.83. The solar mass is 1.99 x 1030 kg".

POLARIS

"Polaris (alpha UMi) is the current **pole star for the Northern Hemisphere**; it is 1 degree from the exact Northern celestial pole.

Polaris is a **blue-green Cepheid variable star** (its size brightness changes periodically, with period of 3.969778 days; it varies between mag 1.92 and 2.07). Polaris has a relatively dim companion star (9th magnitude). Polaris' distance from Earth has been estimated to be from 360 to 820 light years.

At its brightest, Polairs is about 6,000 to 10,000 times brighter than our Sun. It is the larger star at the end of the handle of the Little Dipper (Ursa Minor). Polaris is also called the Lodestar or the Cynosure."

"**CEPHEID VARIABLE STARS** Cepheid variables are supergiant stars that regularly pulsate in size and change in brightness. As the star increases in size, its brightness decreases; then, the reverse occurs. The luminosity is proportional to the period. Cepheid Variables may not be permanently variable; the fluctuations may just be an unstable phase the star is going through. Polaris and Delta Cephei are examples of Cepheids."

Finding Polaris

The link above is an excellent site with an animation that will assist in understanding how to spot the North Pole star.

SUPERGIANT STARS

"A supergiant is the largest known type of star; some are almost as large as our entire solar system. Betelgeuse and Rigel are supergiants. These stars are rare. When supergiants die they supernova and become black holes."

RED GIANTS

"A red giant is a relatively old star whose diameter has swollen enormously. It's temperature has also cooled appreciably, it's contracting hydrogen core has turned to helium and eventually to carbon. Our Sun will become a red giant star in about 5 billion years."

BLUE SUPERGIANT

“A blue giant is a huge, very hot, very luminous, blue star. It is not a main sequence star but a post-main-sequence star. These incredibly hot stars burn helium. These giants have the spectral type O or B and are very rare and very bright. Blue giants have at least 18 times the mass of the Sun. Examples include Rigel and Regulus.”

RED DWARFS

"A red dwarf is a small, cool, very faint, main sequence star whose surface temperature is under about 4,000 K. Red dwarfs are the most common type of star. Proxima Centauri is a red dwarf."

WHITE DWARFS

"A white dwarf is a small, very dense, hot star near the end of its life. It is made mostly of carbon. These faint stars are what remain after a red giant star loses its outer layers. Their nuclear cores are depleted. They are about the size of the Earth (but are heavier). Our Sun will someday turn into a white dwarf. The companion of Sirius is a white dwarf."

References and Credits:

New York State Earth Science Reference Tables 2001 Edition
Temperatures and Colors of the Stars
Enchanted Learning: Zoom School Astronomy Glossary
Enchanted Learning: Star Types

Definitions for stars and concepts on pages 3 and 4:
Zoom Astronomy Glossary

Name: _____ Date: _____

Class: _____ Teacher: _____

Understanding the H-R Diagram Assignment

Directions:

Answer the following questions basing your answers on the lesson and Luminosity and Temperature of Stars, H-R Diagram on pages 1-4.
With the exception of number 4, which is a multiple choice question, write all other responses in complete sentences on the blanks provided.
Note that questions 8 and 10 have 2 parts.

Questions:

1. What type of star is massive, with extremely hot temperatures and a very high luminosity?

_____

_____

2. Name a **Main Sequence Star** that is similar in characteristics to our Sun but that is slightly more luminous.

_____

_____

3. What determines the color of a star?

_____

_____

4. Which of the following describes our **Sun**:

a. The Sun is a blue star with a high luminosity and extremely hot temperatures.
b. The Sun is a yellow star, considered to be average, and is the reference point for the luminosity chart.
c. The Sun is a red, low temperature star with a low luminosity.

Answer *(Write the correct letter.)* _____

5. **Polaris** is considered to be a **Cepheid Variable** star.
Explain what this means and state 3 things about Polaris: its approximate luminosity and temperature, as well as its color, according to the H-R Diagram.

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6. The life cycle of our Sun, over the next 5 billion years, will eventually take it into the Red Giant Stage and then finally to the White Dwarf Stage.
Explain what this means, with respect to luminosity and temperature, as sun as it reaches each of these two stages.

_____

_____

_____

_____

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_____

7. Name a star that is presently at the stage that our Sun will be in at the end of its life span.

_____

_____

8a. What type of star has both a low luminosity and low temperature.

_____

_____

8b. Name a star in this category.

_____

_____

9. Name a star that is a **blue supergiant**, which has a luminosity of 20,000 and a temperature of 12,000°C - 13,000°C.

_____

_____

10a. What color are stars with very low temperatures?

_____

_____

10b. What color are stars with very high temperatures?

_____

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