Name:_____ Block:_____

Stellar Evolution Notes

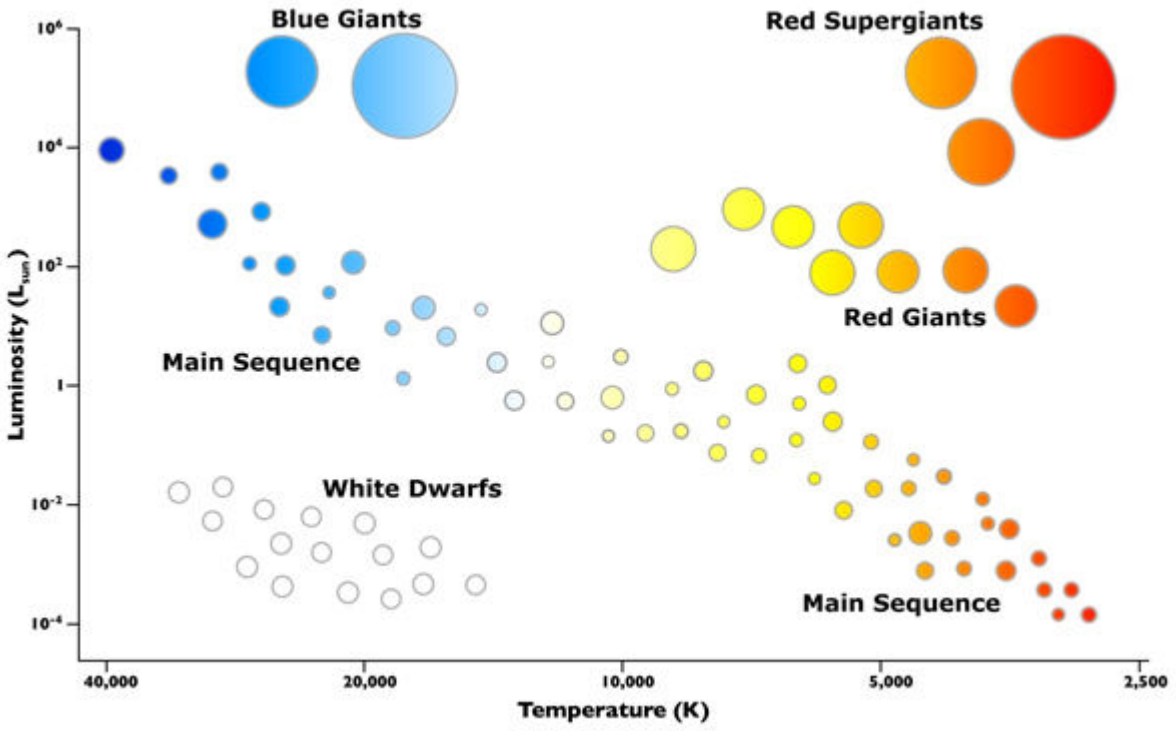
Stars mature, grow old and die. The more massive a star is, the shorter its life will be. Our Sun will live about 10 billion years. It is already 5 billion years old, meaning it will live another 5 billion years.

Luminosity –

- The actual brightness of a star is its **luminosity**. It depends only on size and temperature.
- A star's **absolute magnitude** is a measure of how bright the star would be if all stars were the same distance from earth. A star's **apparent magnitude** is a measure of how bright the star appears to an observer on Earth.

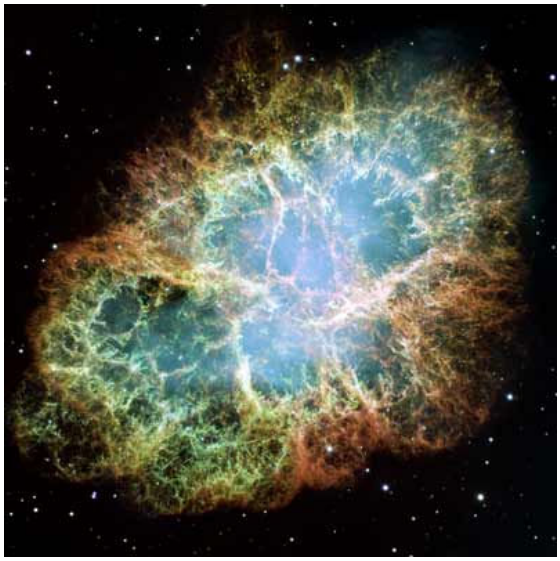
Hertzsprung-Russell Diagram (H-R)

- is a graphical tool that astronomers use to classify stars according to their luminosity, spectral type, color, temperature and evolutionary stage. Notice that the scales are not linear.
- Hot stars inhabit the left hand side of the diagram, cool stars the right hand side. Bright stars are at the top, faint stars at the bottom.
- Our Sun is a fairly average star and sits near the middle.



Nebula –

- The most abundant element in the universe is hydrogen.
- A star is a sphere of super-hot gases, mostly hydrogen and helium that is held together by its own gravity. No two stars contain exactly the same elements in the same proportions. Stars are born by contraction of gasses inside a nebula.
- A nebula is a cloud of interstellar dusts and gasses.
- A protostar is the birth of a star. They are starting out in their life as a star. Eventually, a protostar's center becomes so hot that a fusion reaction begins. When fusion begins, a star is born



The Crab Nebula is a supernova remnant, all that remains of a tremendous stellar explosion. Observers in China and Japan recorded the supernova nearly 1,000 years ago, in 1054.

Main-Sequence Star

- Eventually, the temperature inside a protostar becomes hot enough (about 10,000,000°C) for **nuclear fusion** reactions to begin converting hydrogen into helium.
- Once fusion begins, the star becomes stable, because it then has enough internal heat to produce the pressure needed to balance gravity.
- It takes about 10 billion years for a star with the mass of the Sun to convert all of the hydrogen in its core into helium.
- When the hydrogen in its core is gone, a star has a helium core.
- Hydrogen fusion continues surrounding the helium core, causing the star to expand and cool.

Red Giant

- The energy produced in the thin hydrogen layer forces the outer layers of the star to cool and expand and the star becomes a **red giant**.
- During this stage, the core becomes hot enough, at 100 million C, for helium to fuse and form carbon.
- The original mass of the star determines whether it will become a giant or supergiant (see massive star cycle)

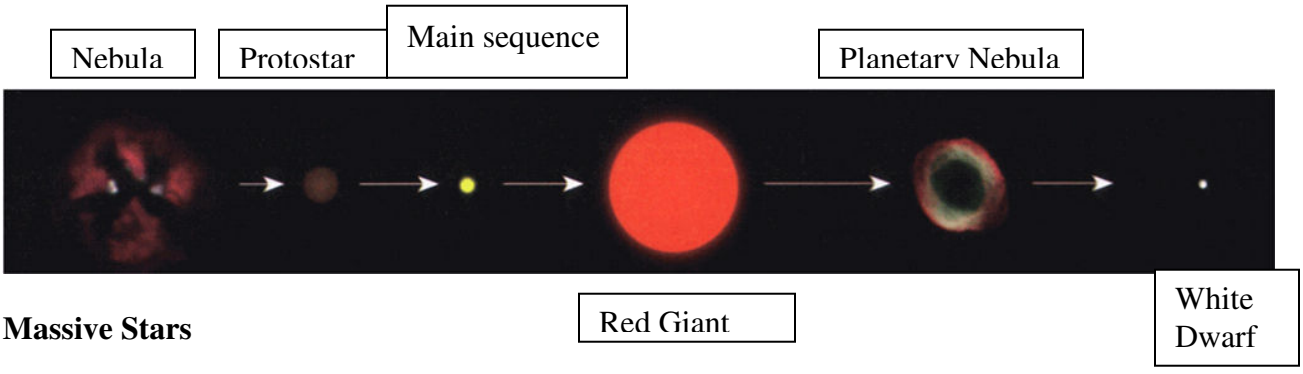
Planetary Nebula

- A star of the Sun's mass never becomes hot enough for carbon to fuse, so the star's energy production stops at this point.
- The core collapses due to gravity and the outer layers are blown off entirely becoming a shell of gas, which is the planetary nebula.

7)White Dwarf

- In the center of a planetary nebula, the core of the star remains as a white dwarf made of carbon.
- A white dwarf fades away as the billions of years pass. Since no new energy is being produced inside, and light is escaping into space, the star corpse cools down until it becomes black as space. Astronomers call these corpses **black dwarfs**.

EVOLUTION OF A STAR WITH A MEDIUM MASS



Massive Stars

Massive Stars

- 10 to 100 times more massive than the sun
- Begin the same as other stars
    - Nebula
    - Protostar
    - Main sequence (but massive in size)
    - Red supergiant
- Helium fusion into carbon and oxygen.
- The star continues to expand and cool, while the core collapses due to gravity and heats up.
- Carbon and oxygen fuse to form neon, then magnesium, then silicon, then iron.
- The temperature of an iron core can reach 3 billion degrees.

Supernova

- The iron core collapses and the star explodes.
    - The explosion drives a blast wave into the surrounding space, forming a supernova remnant.

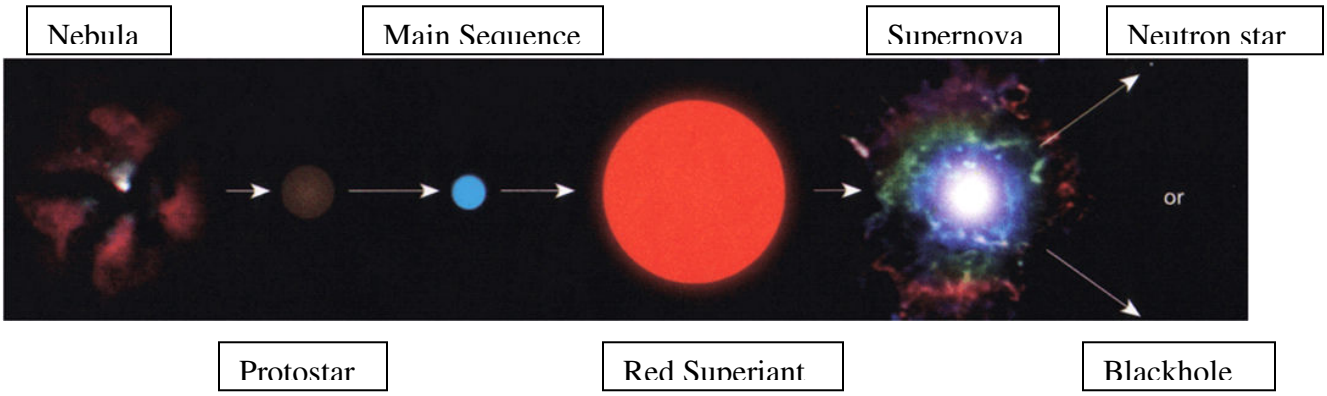
Neutron Star

- Core of a supernova explosion.
- Incredibly dense ball of neutrons.
- Rotates very rapidly- pulsars

Black Hole

- Massive remnant of a supernova explosion.
- Gravity so intense that light cannot escape from it.
- Identified by X-Ray emissions.
- Supermassive black holes are believed to exist in the center of most galaxies, including our own Milky Way Galaxy.
- A galaxy is a group of hundreds of billions of stars that are relatively close to each other. Our galaxy, the Milky Way, contains over 100 billion stars. The universe has more than 100 billion galaxies with each galaxy containing an average of 100 billion stars.

EVOLUTION OF A STAR WITH A LARGE MASS



Star Life Cycle Video: http://www.youtube.com/watch?v=H8Jz6FU5D1A
Largest star ever recorded video: http://www.youtube.com/watch?v=g4iD-9GSW-0