Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period\_\_\_\_

**NOTE OUTLINE: Ch 30-31 Stars & Universe**

# Objectives

1. Describe electromagnetic radiation (EM). This means I can:
   1. Describe how the EM is organized and which forms of EM waves are the most and least dangerous.
   2. Explain the relationship between wavelength & frequency.
2. Classify the types of stars. This means I can:
   1. Describe the 3 main characteristics we use to describe stars; color, size, brightness (magnitude & luminosity).
   2. Summarize how those 3 main characteristics are interrelated.
3. Walk stars through their life cycle and predict how they will die. This means I can:
   1. Compare the evolution and death of stars of different masses.
4. Define and apply the following vocabulary terms: apparent magnitude, absolute magnitude, luminosity, HR-diagram, main sequence, black hole, planetary nebula, neutron star, protostar, supernova, fusion.
5. Explain the Big Bang Theory and how Redshift of light gives evidence for the theory.

**What is Astronomy?**

1. The study of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**How can we study it?**

1. Study things that make it to Earth
   1. Meteorites
   2. Samples Collected
2. Study the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_that makes it to Earth
3. Study light in space
   1. What is the light doing? / What’s releasing light?

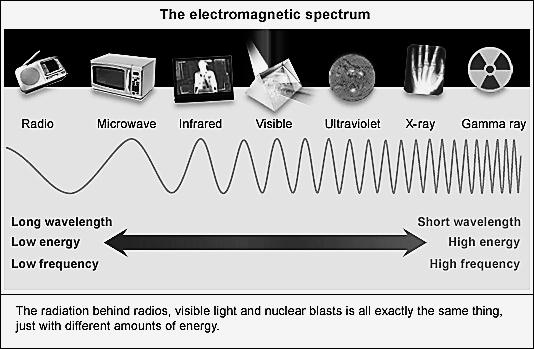
**What is Light?**

1. Light = Radiation of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_spectrum (EM)
   1. EM spectrum includes waves of all different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that travel through space, NOT just visible light
   2. Energy is used to organize light (EM waves) into categories
   3. Types: Radio waves (\_\_\_\_\_\_\_\_\_\_\_\_\_ dangerous), microwave, infrared, visible light, UV,

X-rays, gamma rays (\_\_\_\_\_\_\_\_\_\_\_\_ dangerous)

* + - **Note** – Visible light is the “dividing” line of dangerous vs. non-dangerous forms of EM waves

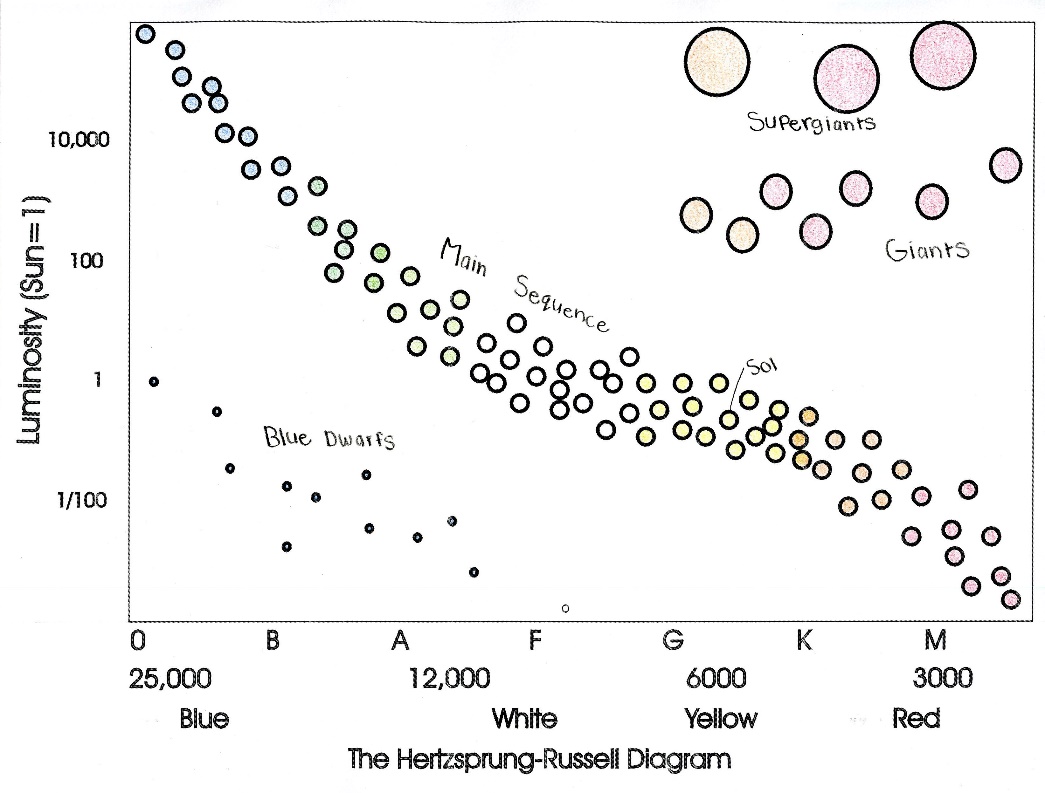
**Video**: Electromagnetic Radiation Song <https://www.youtube.com/watch?v=bjOGNVH3D4Y>

* 1. Sorted by Wavelength and Frequency
  2. Wavelength: The distance until a wave repeats itself
     1. Measured from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. \_\_\_\_\_\_\_\_\_\_\_\_ wavelengths are more dangerous because they have more energy
  3. Frequency: Number of waves in a given time interval.
  4. Wavelength & Frequency are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Chapter 30 Stars**

Stars: Examine the **HR-Diagram** below. Stars - Are they all alike? How do they differ?



**Beginning of a Star Lifecycle**

1. **Interstellar Cloud/\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   1. Big cloud of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Once enough gas has collected the nebula will condense forming a….
2. **Protostar: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   1. As the protostar continues to condense it will heat up until it hits Critical Mass and…
3. **Nuclear fusion begins**
   1. Now we have a real \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ star.
   2. Main Sequence = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as long as fusion occurs & as long as

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ available

**What is a Star?**

* 1. Star = A cloud of gas, mainly \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with a core so hot and dense that

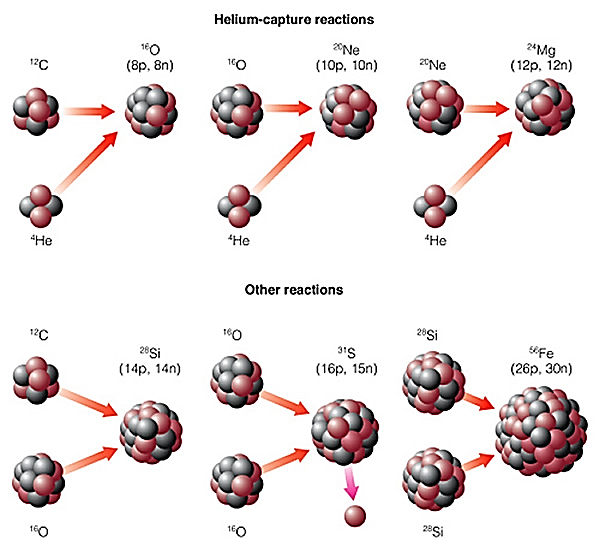
that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can occur.

* 1. Purpose/Jobs
     1. Provide\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Warms Planet Earth
  + Photosynthesis – base of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ which produces \_\_\_\_\_for breathing
    1. Nuclear fusion within stars converts light (low mass) elements (\_\_\_\_\_\_) into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ones (C, O, Ne, Mg, Si, Fe)

**Nuclear Fusion**

1. **Creates new more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements**
   * Without these life would not be able to form
2. **Will continue in a star until no heavier element can be produced**
   * \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the ultimate stopping point
3. **Helps balance out the force of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ trying to act on stars**
4. **When fusion stops, gravity will win and cause the star to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** 
   * This is when a star begins to die



**Important Star Qualities**

**Three Main Characteristics**

* 1. **Brightness/Magnitude/Luminosity**
  + Light releasing capacity
  1. **Color**
  + Determined by Temperature
  1. **Size**
  + Large - usually blue, hot, bright
  + Small - usually red, cool, dim
  + Determines means of Death

**Terms Describing a Star’s Brightness & Energy Output**

1. **Apparent** magnitude= How bright the star \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

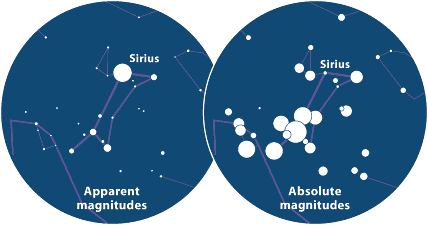
* 1. What can cause a bright star to look dim? It’s \_\_\_\_\_\_\_\_\_\_\_\_\_:

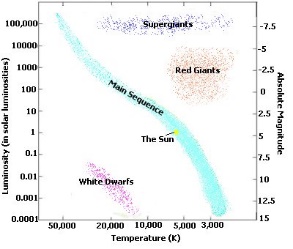
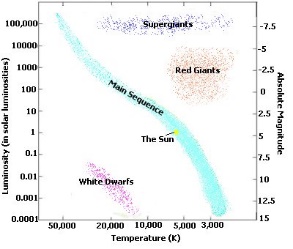
Bright star looks dim if it is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. What can cause a dim star to look bright? It’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:

Dim star looks bright when it’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Absolute** magnitude **= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** brightness based on how bright stars would look if they were \_\_\_\_\_\_ the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ away.
2. **Luminosity** Measures how much \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ IS GIVEN OFF.
   1. Absolute magnitude & Luminosity closely related
   2. Discuss lumens of light bulbs





**Scales for Magnitude & Luminosity**

While Absolute Magnitude is a result of the energy (luminosity) of the stare, magnitude and luminosity have different scales, and they are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ proportional.

1. Absolute Magnitude:
   1. \_\_\_\_\_\_\_\_\_\_\_ numbers = BRIGHTER star
2. Luminosity:
   1. \_\_\_\_\_\_\_\_\_\_\_ numbers = BRIGHTER star

**Color of Stars**

1. Stars are identified by their color, which indicates their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. They are divided into what are known as spectral classes.
   * + - These classes are O, B, A, F, G, K, and M.
       - Class O stars are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_and are \_\_\_\_\_\_\_\_\_\_ in color.
       - The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ stars are identified as class M and are \_\_\_\_\_\_\_\_ in color.

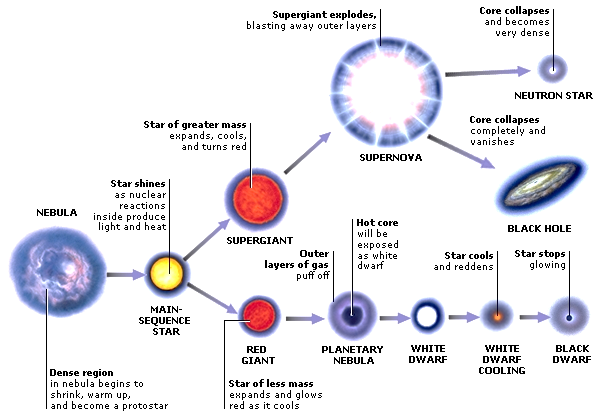
**Star Size**

1. Determines the length of a star’s life
   1. Large Stars = Burn out \_\_\_\_\_\_\_\_\_\_\_\_ because of \_\_\_\_\_\_\_\_\_\_\_pressure in core, causing

fusion to occur \_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_ used up faster.

* 1. Small Stars = Use fuel more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     + Around for a much \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_time.

1. Star size also determines the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a star will take.



**Death of an AVERAGE Size Star**

* 1. **Fusion of Hydrogen Stops**
     1. No longer a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. **Red Giant**
     1. Large star that is reddish or orange in color
     2. Reaching sizes of over \_\_\_\_\_\_\_ times the star's original size.
     3. Late phase of development in a star's life
     4. Hydrogen has been exhausted and \_\_\_\_\_\_\_\_\_\_\_ is being fused.
        1. This causes the star to collapse, raising the temperature in the core.
        2. The outer surface of the star expands and cools, giving it a reddish color.
     5. This phase will continue until the star completely runs out of \_\_\_\_\_ (When Fe made)
     6. Each cycle of collapse & expansion leads to next step in fusion sequence.

Examples: H+H He, He +C O, C +O Si, Si + Si Fe

1. **Planetary Nebula**
   * 1. When nuclear \_\_\_\_\_\_\_\_\_\_\_\_ (Fe, iron, made. Fe \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in star)
     2. Stars blow away their outer layer of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. **White Dwarf**
   1. Remaining core of the star left behind after the planetary nebulae
      * Present after \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has blown away
   2. Still very hot so it glows white until it cools off
3. **Black Dwarf**
   1. Cooled off \_\_\_\_\_\_\_\_\_\_\_\_\_\_of a star

**Death of a MASSIVE Star**

1. **Fusion of Hydrogen Stops**
   1. No longer a main sequence star
2. **Red Supergiant** (Same info as Red Giant – just larger size)
   1. **Extremely large** star that is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in color
   2. Reaching sizes of over \_\_\_\_\_\_\_\_\_\_\_\_ times the star's original size.
   3. Late phase of development in a star's life
   4. Hydrogen has been exhausted and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is being fused.
      * This causes the star to collapse, raising the temperature in the core.
      * The outer surface of the star expands and cools, giving it a reddish color.
   5. This phase will continue until the star completely runs out of fuel – When \_\_\_\_\_\_\_\_\_\_\_\_ is made. \_\_\_\_\_\_\_\_\_ can’t fuse in star.
      * Betelgeuse in Orion is an example of a red supergiant star.
3. **Supernova**
   1. Violent explosion –causes fusion to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Ejects most of its mass.
   3. Often briefly outshines an entire \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   4. Fades from view over several weeks or months

**Now, ONE of the following 2 steps occurs** – **EITHER neutron star OR Black Hole**

1. **Neutron Star** 
   * 1. If the remaining mass of the star is about \_\_\_\_\_\_\_ times that of our Sun, the core is unable to support itself and it will collapse further to become a neutron star.
     2. The matter inside is compressed so tightly that its atoms are compacted into a dense shell of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

OR

1. **Black Hole** (The **LARGEST stars** take this route)
2. If the remaining mass of the star is more than about\_\_\_\_\_\_\_ times that of the Sun, it will collapse so completely that it will literally disappear from the universe.
3. What is left behind is an intense region of gravity called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Big Bang – Theory of Universe Formation**

According to the theory:

1. The entire universe was hot, dense mass, just a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ across.
2. Approximately \_\_\_\_\_\_\_\_\_\_\_\_\_ years ago, an unknown type of energy caused a

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that caused the universe to \_\_\_\_\_\_\_\_\_\_ from a pebble-size

origin to astronomical size.

1. As time passed and matter cooled:
   1. Diverse kinds of atoms form (Small atoms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into larger ones)
   2. Particles condensed & pulled by \_\_\_\_\_\_\_\_\_\_\_\_\_\_ into stars & galaxies.
2. Evidence for Theory: Galaxies are moving \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ours at great speed, in all directions, as if propelled by an explosive force (Big Bang)
3. Expansion \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but much more slowly now billions of years later.
4. Major questions still unanswered; What is the original cause of the Big Bang itself?
   1. Answers have been proposed, but none proven.
   2. Testing potential answers is a challenge.

**Demo – “Stretching Space” POE = Predict, Observe, Explain**

1. Draw waves as seen on the unstretched elastic bandage:
2. **Predict & Explain:** What will happen to the wave as we stretch the bandage?
3. **Observe & Explain:** What happens as the bandage is stretched? Draw waves as seen on the stretched elastic bandage. Be sure to show any differences from the original unstretched elastic bandage.
4. **Extend & Explain:** If the wavelength had been “yellow” to begin with, would the stretched wavelength become blue or red? Explain using wavelength and the EM Spectrum

**Evidence for Expansion of Universe: Red Shift**

1. Astronomers have discovered that \_\_\_\_ distant galaxies are moving \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ us.
2. The farther away the galaxies are, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ they are moving.
3. As the galaxies move away, waves are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ causing:
   1. Wavelengths to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occurs. (\_\_\_\_\_\_ waves are the \_\_\_\_\_\_\_\_\_\_\_ waves in the EM Spectrum.)
4. “Red-shift” of light from distant galaxies gives evidence for Big Bang.

Video of Redshift Simulation <https://www.stem.org.uk/elibrary/resource/29947/redshift>

