1141 Exam 4 Study Guide

November 22, 2021

1 Planetesimals in the Solar System

a. What is peculiar about Pluto relative to the planets?

- Pluto is rocky, making it unlike the Jovian planets further out in the solar system
- It's orbit is highly eccentric, crossing Neptune's orbit, and it extremely tilted compared to the planets orbits
- It is very small, even smaller than many of the larger moons of the planets, such as Earth's moon or Triton.
- It's located in an orbit with many other things, the Kupier Belt. This is the main reason it was reclassified as a dwarf planet.

a. What is the Asteroid Belt? Where is it? Is it continuous?

- The asteroid belt is an area located between the orbits of Mars and Jupiter, containing many rocky/metallic bodies (asteroids)
- It is believed to be either a planet that couldn't form, or a planet that was ripped apart by Jupiter
- It has gaps, such as the Kirkwood gap, at orbital resonances with Jupiter.

a. What is the Kuiper Belt? Where is it?

- The Kuiper belt is a region outside of Neptune's orbit full of icy/rocky bodies.
- It is where Pluto spends much of its time and where many of the comets in our solar system come from.

a. What is the Oort Cloud? Where is it?

- The Oort cloud is a spherical shell of mostly icy bodies at the edge of our solar system
- It is where the many of the comets in our solar system come from.

a. What are asteroids? What are they made of? Are they a large portion of mass in the solar system?

- Asteroids are rocky/metallic bodies, mostly made of metals and silicates, with some organic compounds, that mostly life in the inner solar system.
- most reside in the asteroid belt, though there are also asteroids moving around between planets, or following a planets orbit.
- All the asteroids in the solar system add up to about 1/1000 the mass of the Earth.

a. What are Meteors? Meteorites?

- Meteors are debris such as small asteroids that fall through our atmosphere, lighting and heating up as they collide with air.
- Meteorites are the remaining materials that make it to the surface of the Earth, often making a crater upon landing.
- They are very rocky and metallic, possibly even having pure iron, which doesn't occur naturally on Earth, where it is found in ores.

a. What are Comets? What are they made of?

- Comets are small icy bodies with orbits taking them between the far outer regions of the solar system and closer to the sun.
- They are primarily ice, with some rocks and metals mixed in.

a. What are the parts of a comet?

- A comet sun has four main parts: Nucleus, Coma, H Cloud, and tail.
- The tail actually has two parts, the dust tail and the ion tail. The ion tail always points directly away from the sun, while the dust tail follows the path of motion a little closer.

a. Do Comets make up a large portion of mass in our solar system?

- Yes. If you could combine all the comets in the solar system, out to the Oort cloud, you would get 1000 times the mass of the Earth, roughly the amount of mass as all the 8 planets combined.

2 Stars and their Classifications

a. What are the spectral types of stars? What can we tell about a star from its spectral type?

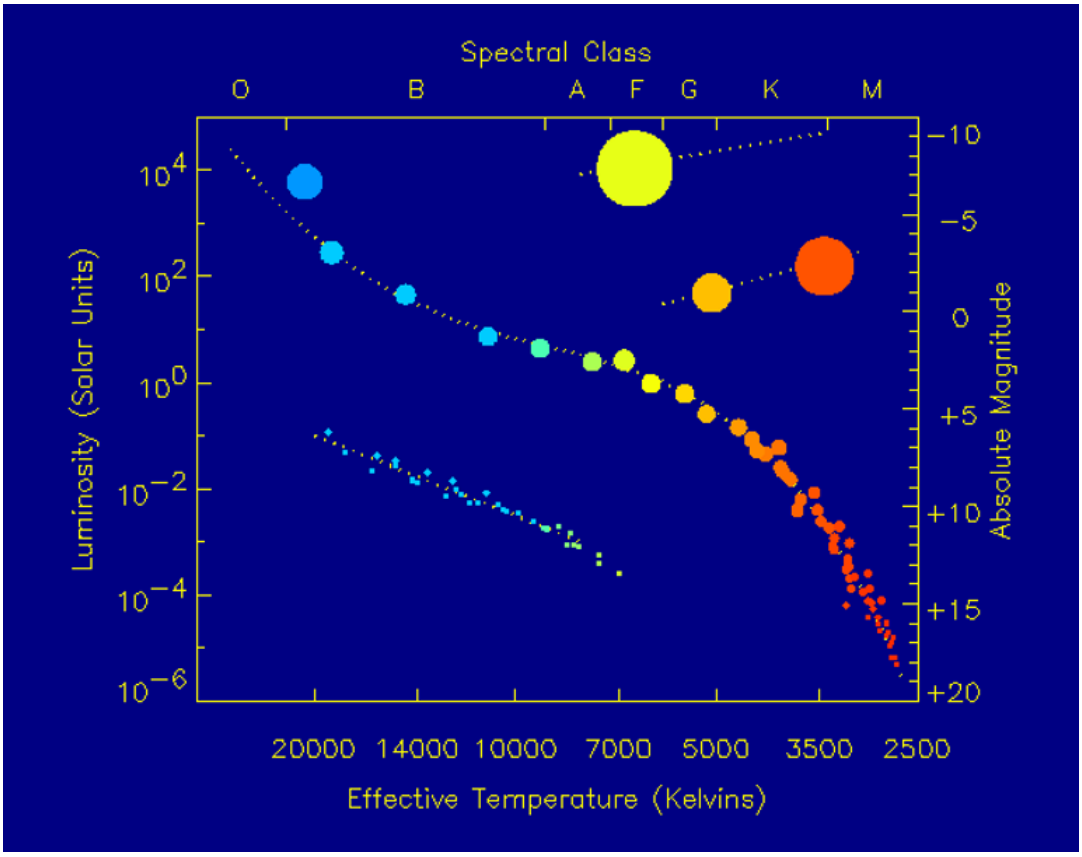
- The spectral types are O,B,A,F,G,K,M. They denote the color, or temperature of a star.
- The spectral types can tell us roughly how hot a star is. A M star can be as cool as 1600-2000 K. An O star can be as hot as 30000-50000 K!

a. What are the Luminosity Classes of stars? What do they mean?

- The luminosity classes are in roman Numerals, I,II,III,IV, and V. The classes denote different types of stars based on their luminosity.

- Class V stars are Main sequence stars, and each successive class gets brighter. III are giants and I are supergiants.

a. What is an HR Diagram? What are its axes? What are the main features?



- An HR diagram is a plot of spectral color versus luminosity. Like shown below.
- It's x-axis can be temperature or color/ spectral type. All three correlate with each other. It goes hot to cold from left to right
- It's y-axis is luminosity. it goes from high luminosity up top to low luminosity at the bottom

a. What is the Main Sequence? How do stars on the main sequence get energy?

- The main sequence is the curved line in the middle of the HR diagram that represents where stars fusing hydrogen into helium are.
- Their source of energy is Hydrogen fusion, and it takes a long time for them to fuse enough hydrogen to leave the main sequence.

a. What determines how much energy a star releases?

- Directly, the luminosity of a star, or how much energy it puts out per second, is determined by the radius and temperature of a star. $L \propto R^2T^4$ A star with twice the radius will be 4 times as luminous, but a star with twice the temperature will be 16x as luminous.

- A star with more mass gets denser and hotter, letting it fuse hydrogen faster and produce more energy.

a. What type of star is the sun? What will happen to the sun when it leaves the main sequence?

- The sun is a G2V star. It's spectral type, G2 means it is around 6000 K. It's luminosity class, V, means it is on the main sequence.
- When the sun leaves the main sequence, it will expand into a red giant, then turn into a nebula, leaving behind a white dwarf.

3 How does life work?

a. What are the six properties of life on Earth?

- Order / Structure - there are coherent patterns of molecules
- Reproduction - Living organisms can make copies of themselves
- Growth and Development - Living organisms can increase in mass and add capabilities
- Energy Utilization - (Metabolism) Organisms take in and use energy from their environment
- Response to Environment- Organisms can sense and react to their environment
- Evolutionary Adaptation - Living organisms evolve to adapt to their environment

a. What are DNA and RNA? What do they do?

- DNA (Deoxyribonucleic Acid) contains hereditary information and is used to store and pass on that information, such as how to create amino acids.
- RNA (Ribonucleic acid) is used to generate proteins and enzymes, which help the organism function.

a. What are the domains of life? How are they distinct? Which one do humans belong in?

- The three Domains of life are: Bacteria, Archaea, and Eukarya.
- The primary feature is the organisms in Eukarya have cells that have nuclei, whereas the other two do not.
- Humans belong to Eukarya.
- Prokaryotes (cells in bacteria or archaea) are also smaller than Eukaryote, due to not having a nucleus.

a. What makes an organic compound? Why is this special?

- Organic compounds contain carbon.
- Carbon is extremely versatile and unique, allowing for single, double and triple-bonds, allowing for vast amounts of different compounds.

a. What types of organic molecules are there? What do they do?

- There are 4 primary organic molecules: Carbohydrates, Lipids, Proteins and Nucleic Acids.
- Carbohydrates are used for storing and supplying energy (sugars) or providing sturcture to cells (cellulose)
- Lipids (Fats) are alose primarily used to store and release energy
- Proteins are used to drive cellular function, and are comprised of amino acids.
- Nucleic Acids are molecules such as DNA and RNA

a. What is Photosynthesis, why is it so integral to life on Earth?

- Photosynthesis is the chemical process in plants that converts CO2 and water into O2 and sugar.
- The sugars and oxygen that much of life uses to produce energy through metabolism comes from this process. If not for photosynthesis, there would be very little oxygen and essentially no sugars for life to use.

a. What is the habitable zone? Why do we care about it?

- The habitable zone is the thin region around a star where liquid water can exist.
- There is enough heat from the star to melt ices, but not so much as to make it evaporate at the surface.
- Life as we know it relies on liquid water for many processes, so when looking for life in the universe, looking for planets in the habitable zone is a good starting point.
- Earth is in the habitable zone, but still relies on the greenhouse effect to keep enough heat over the whole planet at once to allow for liquid water.