

**TEST #1**  
**March 11, 2021**

1. Explain in detail the process of scientific discovery. For a theory to be *scientific*, which three criteria need to be fulfilled? What is the difference between a scientific theory, a pseudo-scientific theory, and a non-scientific theory? Provide an example of each.
2. The Hertzsprung-Russell diagram is arguably one of the most important diagrams in all of astronomy. Understanding it is of utmost importance for understanding the connections between fundamental stellar parameters such as mass, radius, temperature and luminosity.
  - a) Sketch an H-R diagram. Do not forget to label axes, provide approximate tickmark values and draw the main sequence, the giant branch, and the white dwarf region.
  - b) Denote spectral types and luminosity classes on your sketch of an H-R diagram, and pinpoint the approximate location of the Sun.
  - c) Draw an evolutionary track of the Sun from the moment it lands on the main sequence, to the moment it ends its life.
  - d) Explain how an H-R diagram of a globular cluster can be used to determine its age.
3. Let's now focus on our Sun and stars similar to the Sun; what sources of energy have been hypothesized and rejected, and on what basis? What source of energy is the only viable source? Explain that process.
4. Spectral lines serve for many things in astronomy; one of the most important role is figuring out whether an object is approaching us or receding from us. Explain how do we use spectral lines to figure that out. Do not forget to discuss the underlying principle that enables us to do so (i.e. what causes spectral lines to "react" to motion towards us/away from us).
5.  $^{13}\text{N}$  decays into  $^{13}\text{C}$  with a half-life of 9.965 minutes.
  - a) Is this an  $\alpha$ ,  $\beta$  or  $\gamma$  process? Explain why by explaining *only* the chosen process.
  - b) How much  $^{13}\text{N}$  remains after 1 hour?
  - c) After what time will there be 99%  $^{13}\text{C}$ ?
  - d) Is  $^{13}\text{N}$  decay practical for dating artifacts from ancient human history? Why?
6. Name the 4 fundamental forces in nature and provide an example of a process that would not be possible if it weren't for each particular force.