TEST #2
April 26, 2023

1. The nebular theory explains the formation of stars and planetary systems. Explain how the theory predicts the initial contraction and disk formation, how the protostar and planetesimals are formed, why we have two types of planets, and how is the remainder of the nebula cleared.

2. How do we measure distances to the stars using the parallax method?

3. Stellar clusters help us understand and study stellar populations and stellar ages.

   a) What are the two types of stellar clusters, and some of the main differences between the two types?

   b) What is the color-magnitude diagram? Why is it only useful for clusters and how do we use it to determine cluster populations?

   c) What determines the turn-off point on the color-magnitude diagram? Explain.

   d) How are the Hertzsprung-Russell diagram and the color-magnitude diagram related to one another? *Hint:* think of the lab where you did this.

4. Other than high temperature and high pressure, what two other considerations do we need to explain the rate of nuclear reactions in the core of the Sun?

5. Barnard's star is a main sequence star, while Procyon B is a white dwarf. Find the two stars on the H-R diagram and circle them.

   a) Read off their absolute magnitude and convert it to luminosity. Express it in terms of solar luminosity.

   b) Read off their spectral types and convert them to temperature by using both H-R diagrams. Express them in terms of solar temperature.

   c) Calculate the radii of Barnard's star and Procyon B. How do their sizes compare?

   d) Calculate the mass of Barnard's star. Express it in kg.

   e) *Bonus question:* Procyon B's mass is $0.6\,\mathcal{M}_\odot$. What is its average density? How does that compare to the average density of the Sun? *Hint:* $\rho = \mathcal{M}/V$, and volume of a sphere is $4\pi R^3/3$.

6. Which of the three radioactive decays can turn protons into neutrons and vice versa? Explain the process and the by-products.