

# SELF-STUDY QUESTIONS

February 2010

## Hydrogen burning

1. Electron capture occurs in one of the pp-chains. Which one? Which nuclei are involved?
2. Hydrogen burning involves a series of nuclear reactions referred to as the pp-chains. Two of the pp-chains are responsible for most of the energy production. Describe these two pp-chains.
3. In which type of stars are the pp-chains the most important hydrogen burning process?
4. In which type of stars is the CNO-cycle the most important hydrogen burning process?
5. Describe the CNO-cycle and explain why the elements C, N and O Consumed. are not

## Helium burning

1. The first step in helium burning is the so called triple-alpha process. Describe this process.
2. Additional helium burning reactions occur after the triple-alpha process. Describe these reactions and explain why there is not a long chain of helium burning reactions which could successively lead to the creation of heavy elements during the normal helium burning phase.
3. A side branch of helium burning starts with the reaction  $^{14}\text{N}(\alpha, \gamma)^{18}\text{F}$  and leads via  $\beta^+$  decay and further  $\alpha$  reactions to the production of  $^{25}\text{Mg}$ . Explain why this chain of reactions is important for the production of heavy elements with a mass larger than about 60.

## Advanced burning

1. After the helium burning phase, a heavy star goes through additional burning phases. What are these burning phases called and what is the dominating end product of each phase?
2. A heavy star has a particular structure when it has used up nearly all its nuclear fuel and is about to collapse. Show this structure by drawing a figure. Indicate the elements that dominate in different regions of the star.
3. Reactions with alpha particles are important during the silicon burning phase. Give examples of a few such reactions. Which are the heaviest elements that can be formed during the silicon burning phase?