Exercise	1	2	3	Total	
100%	5	5	7	17	
Points					

Name:
Stellar Astrophysics

Homework - Lecture 15 - Energy production

Due date: November 1st

1 Endothermic and exothermic reactions

Calculate the amount of energy released or absorbed in the following reactions (express your answers in MeV):

$$^{12}_{6}\mathrm{C} + {}^{12}_{6}\mathrm{C} \rightarrow {}^{24}_{12}\mathrm{Mg} + \gamma$$

$$^{12}_{6}\mathrm{C} + {}^{12}_{6}\mathrm{C} \rightarrow {}^{16}_{8}\mathrm{O} + 2\,{}^{4}_{2}\mathrm{He}$$

$$^{19}_{9}\mathrm{F} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{16}_{8}\mathrm{O} + {}^{4}_{2}\mathrm{He}$$

The mass of $^{12}_{6}\mathrm{C}$ is 12.0000 u, by definition, and the masses of $^{16}_{8}\mathrm{O}$, $^{19}_{9}\mathrm{F}$, and $^{24}_{12}\mathrm{Mg}$ are 15.99491 u, 18.99840 u, and 23.98504 u, respectively. Are these reactions exothermic or endothermic?

2 Nuclear reactions puzzle

Complete the following reaction sequences. Be sure to include any necessary leptons.

$$^{27}_{14}\mathrm{Si} \rightarrow {}^{?}_{13}\mathrm{Al} + \mathrm{e}^{+} + ?$$

$$^{?}_{13}\mathrm{Al} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{24}_{12}\mathrm{Mg} + {}^{4}_{?}?$$

$$^{35}_{17}\mathrm{Cl} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{36}_{18}\mathrm{Ar} + ?$$

3 Hydrogen burning lifetime

Estimate the hydrogen burning lifetimes of stars on the lower and upper ends of the main sequence. The lower end of the main sequence occurs near $0.085\,M_{\odot}$, with $\log_{10} T_{eff} = 3.438$ and $\log_{10}(L/L_{\odot}) = -3.297$, while the upper end of the main sequence occurs at approximately $90\,M_{\odot}$ with $\log_{10} T_{eff} = 4.722$ and

$\log_{10}(L/L_\odot) = 6.045$. Assume that the $0.085\,M_\odot$ star is entirely convective so that, through convective mixing, all of its hydrogen becomes available for burning rather than just the inner 10%.

Look into Chapter 10 in Carroll & Ostlie in case you have problems with the exercises.