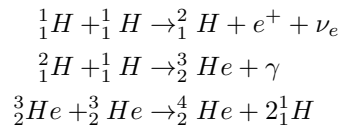


Astronomy 465 — Problem Set 3

Prof. Kelly Douglass

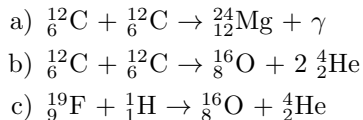
Due Tuesday, October 18 at 2PM EDT

1. The Q value of a reaction is the amount of energy released (or absorbed) during the reaction. Calculate the Q value for each step of the PPI reaction chain:



Express your answers in MeV. The masses of ${}^2_1\text{H}$ and ${}^3_2\text{He}$ are $2.0141u$ and $3.0160u$, respectively.

2. Calculate the amount of energy released or absorbed in each of the following reactions. (Express your answers in MeV.)



The mass of ${}^{12}_6\text{C}$ is $12.0000u$, by definition, and the masses of ${}^{16}_8\text{O}$, ${}^{19}_9\text{F}$, and ${}^{24}_{12}\text{Mg}$ are $15.99491 u$, $18.99840 u$, and $23.98504 u$, respectively. Are these reactions exothermic or endothermic? Where might you find each of these reactions occurring?

3. The lower end of the main sequence occurs near $0.072M_\odot$, with $\log T_e = 3.23$ and $\log(L/L_\odot) = -4.3$. On the other hand, an $85M_\odot$ star near the upper end of the main sequence has an effective temperature and luminosity of $\log T_e = 4.705$ and $\log(L/L_\odot) = 6.006$, respectively.
 - (a) Estimate the hydrogen-burning lifetimes of stars near the lower and upper ends of the main sequence. Assume that the $0.072M_\odot$ star is entirely convective so that, through convective mixing, all of its hydrogen, rather than just the inner 10%, becomes available for burning.
 - (b) Calculate the radii of a $0.072M_\odot$ star and a $85M_\odot$ star. (Hint: Use the Stefan-Boltzmann law.) What is the ratio of their radii?