

Homework Assignment 5

ASTR4201, Fall 2020

Corresponds to Chapter 5 of "To Build a Star" (*TBS*) by E.F. Brown

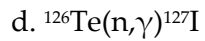
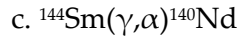
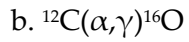
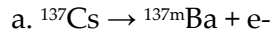
1. TBS exercise 5.1 Team: 3 Lead: Josh
2. TBS exercise 5.2 Team: 2 Lead: Quinn
3. *See below* Team: 1 Lead: Gavin
Considering the terms of the semi-empirical mass formula, which parameter is responsible for the following feature of the nuclear landscape:
 - a. Location of the valley of stability for low A?
 - b. Bend of valley of stability away from N=Z for large A?
 - c. Large A/Z ratios?
 - d. Lack of ultra-high A nuclides?
 - e. Existence of nuclides in the first place?
4. *See below* Team: 3 Lead: Harshil
Calculate the experimental binding energy difference between ^{15}N and ^{15}O [See <http://amdc.impcas.ac.cn/masstable/Ame2016/mass16.txt>]. Assuming this is due to the Coulomb term of the SEMF, what radius corresponds to A=15? Note that compared to a point-charge, a uniformly charged sphere has $U_{\text{sphere}} = (3/5)U_{\text{point}}$. Compare this to the usual approximation for the nuclear radius (using $r_0=1.2\text{fm}$).
5. TBS exercise 5.3 Team: 2 Lead: Michael
6. *See below* Team: 1 Lead: Anthony
There's a maximum in the Binding energy per nucleon (found in TBS 5.3 and shown in the Quick Notes). For measured masses, this is at ^{58}Fe . Why isn't everything made of ^{58}Fe ?
7. *See below* Team: 3 Lead: Ryan
In a single-degenerate scenario, a Type-1a supernova converts a white-dwarf's mass of roughly ^{12}C ($B = 92.162 \text{ MeV}$) to roughly ^{60}Fe ($B = 525.351 \text{ MeV}$). How much energy is this? How does this compare to the gravitational binding energy of the white dwarf? What does this say about the power source of Type-1a's?
8. TBS exercise 5.4 Team: 4 Lead: Jacob
9. *See below* Team: 4 Lead: Gula
If the $^3\text{He}+^3\text{He}$ cross section were purely geometric, what would the S-factor be for a 100keV interaction energy? What about for p+d? Compare to the measured values of $5\text{MeV}\cdot\text{b}$ for $^3\text{He}+^3\text{He}$ and $1\text{MeV}\cdot\text{b}$ for p+d.

10. TBS exercise 5.5 Team: 1 Lead: Brit

11. TBS exercise 5.6 Team: 5 Lead: Justin

12. *See below* Team: 2 Lead: Sam

Which of the following reactions are possible without non-standard model physics? For invalid reactions, indicate what the issue is.



13. *See below* Team: 5 Lead: Robert

For the CNO cycle at near-solar temperatures, the process piles-up at ^{14}N because this rate is the slowest. Where would the process pile-up at if the temperature were very high?