PHY983 - Nuclear Astrophysics - Spring 2009
Homework Set 7
Due: March 20, 2009 at beginning of class
Key words: S-factor, inverse reactions, advanced burning stages

1. [6pt] Imagine you measured the cross section of the ^{44}Ti(p,γ) reaction. Your results are listed below giving the cross section in barn as a function of center of mass energy in MeV (ignore the additional columns):

E (MeV)	sigma(barn)			
0.26179	4.298E-13	0.000E+00	0.000E+00	0.000E+00
0.27872	1.464E-12	0.000E+00	0.000E+00	0.000E+00
0.29716	4.916E-12	0.000E+00	0.000E+00	0.000E+00
0.31724	1.622E-11	0.000E+00	0.000E+00	0.000E+00
0.33911	5.244E-11	0.000E+00	0.000E+00	0.000E+00
0.36292	1.659E-10	0.000E+00	0.000E+00	0.000E+00
0.38886	5.119E-10	0.000E+00	0.000E+00	0.000E+00
0.41710	1.535E-09	0.000E+00	0.000E+00	0.000E+00
0.44786	4.445E-09	0.000E+00	0.000E+00	0.000E+00

Make a table and a graph showing the astrophysical S-factor as a function of energy. Don't forget to indicate the unit for the S-factor.

2. [6pt] Using your experimental data from problem 1, calculate the astrophysical reaction rate for a temperature of 0.1 GK.

Instructions: Calculate the rate from the S-factor in the Gamow window, and assume the S-factor is constant over the Gamow window. If the S-factor needed is outside of the energy range of your experimental data make a reasonable extrapolation.

3. Neon Burning

3.1. [6pt] Calculate the photodisintegration lifetime of ^{20}Ne under neon burning conditions of 1.5 GK using the ^{16}O + α reaction rate from the JINA reaclib database.

3.2. [6pt] Assuming an initial composition at the beginning of neon burning of 35% ^{20}Ne, 60% ^{16}O, and 5% ^{24}Mg (fraction by mass), calculate the composition (fraction by mass) at the end of neon burning when all neon is consumed. You can neglect α capture on Mg and beyond. Compare your result with Fig. 5.47 Pg 485 in Iliadis.