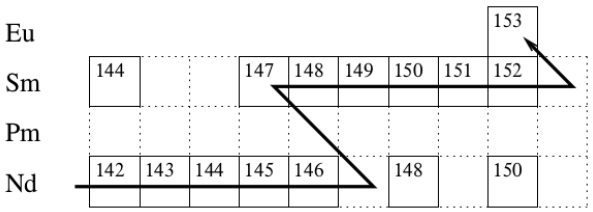
Chemical Evolution of the Universe
Problem sheet 7

1. Compare the thermal neutron capture cross section of the following elements with their geometrical cross sections: $\sigma_n(^{88}\mathrm{Sr}) = 5.8\,\mathrm{mb}$, $\sigma_n(^{100}\mathrm{Ru}) = 5.8\,\mathrm{b}$.

2 points

2. The following figure is a section of the nuclide chart, showing the s-process path:



The following table provides some data for the Samarium isotopes:

A	N_A (%)	σ (mb)
144	2.87	119 ± 55
147	14.94	1173 ± 192
148	11.24	258 ± 48
149	13.85	1622 ± 279
150	7.36	370 ± 72
152	26.90	411 ± 71
154	22.84	325 ± 61

(a) Identify two pure r-process nuclei, two pure s-nuclei and a pure p-nucleus in the diagram.

(b) Using the pure s-isotopes of Sm, and the data in the table, verify the local approximation to the s-process (i.e., $\sigma N \approx$ constant).

(c) Estimate the contribution of the r-process to the abundances of ^{147}Sm and ^{149}Sm.

3 points

3. In an extremely metal-deficient star, thorium is found to be less abundant by 0.2 dex than it would be if the solar system r-process pattern could be extrapolated to thorium. What constraint on the age of the Universe can be derived from this information?
Hint: The half-life of thorium is 14 Gyr and the age of the solar system is 4.6 Gyr.

2 points

4. It is (almost) impossible, to measure isotopic abundances of the heavy elements ($A > 56$) in stars. Which elements can one investigate in order to learn something about r- and s-process abundances in stars of various metallicities?

3 points