## Team Exercises #3

## Problem 1

A reactor is operating for a long time at some known power density  $P_0$ . Then, it instantaneously changes power to some power density  $P_1$ . One fission product of interest is  $^{135}$ Xe, though it has a neglible yield from the initial fission reaction.  $^{135}$ Xe precursors  $^{135}$ Te and  $^{135}$ I are produced with a combined yield, y, of approximately 6%, before decaying via  $\beta^-$  decay to  $^{135}$ I and  $^{135}$ Xe respectively. Find the number density of  $^{135}$ Xe as a function of time after the power change. (For convenience, let  $Q_f$  be the energy produced in a fission reaction, and let  $\phi$  be the flux in the reactor. Your answer may be left in terms of these variables.)

Nucleus	Half-life	Thermal $\sigma_{\rm a}$
$^{135}\mathrm{Te}$	19.0 s	$\sim 0$
$^{135}I$	$6.6 \ \mathrm{hr}$	$\sim 0$
$^{135}\mathrm{Xe}$	9.2 hr	$2.6 \times 10^6 \text{ barns}$

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## Problem 2

- a) Find the excitation energy in <sup>236</sup>U when a neutron with zero kinetic energy is absorbed by <sup>235</sup>U.
- b) Find the excitation energy in  $^{239}$ U when a neutron with zero kinetic energy is absorbed by  $^{238}$ U.
- c) The activation energy for  $^{236}\mathrm{U}$  is 6.2 MeV and the activation energy for  $^{239}\mathrm{U}$  is 6.6 MeV. Will fission occur in each of these cases? Identify  $^{235}\mathrm{U}$  and  $^{238}\mathrm{U}$  as fissile or fissionable and explain.
- d) A  $^{238}$ U nuclei absorbs a 2 MeV neutron and fissions into  $^{132}$ Sn,  $^{106}$ Mo, and a neutron. If the neutron is produced with 2.5% of the total energy released in the reaction, does it have enough energy to fission another  $^{238}$ U atom?

Nucleus	Mass	
n	1.00866492 amu	
$^{106}\mathrm{Mo}$	105.918137 amu	
$^{132}\mathrm{Sn}$	131.917816 amu	
$^{235}{ m U}$	235.043930  amu	
$^{236}U$	236.045568  amu	
$^{238}{ m U}$	238.050788 amu	
<sup>239</sup> U	239.054293  amu	

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