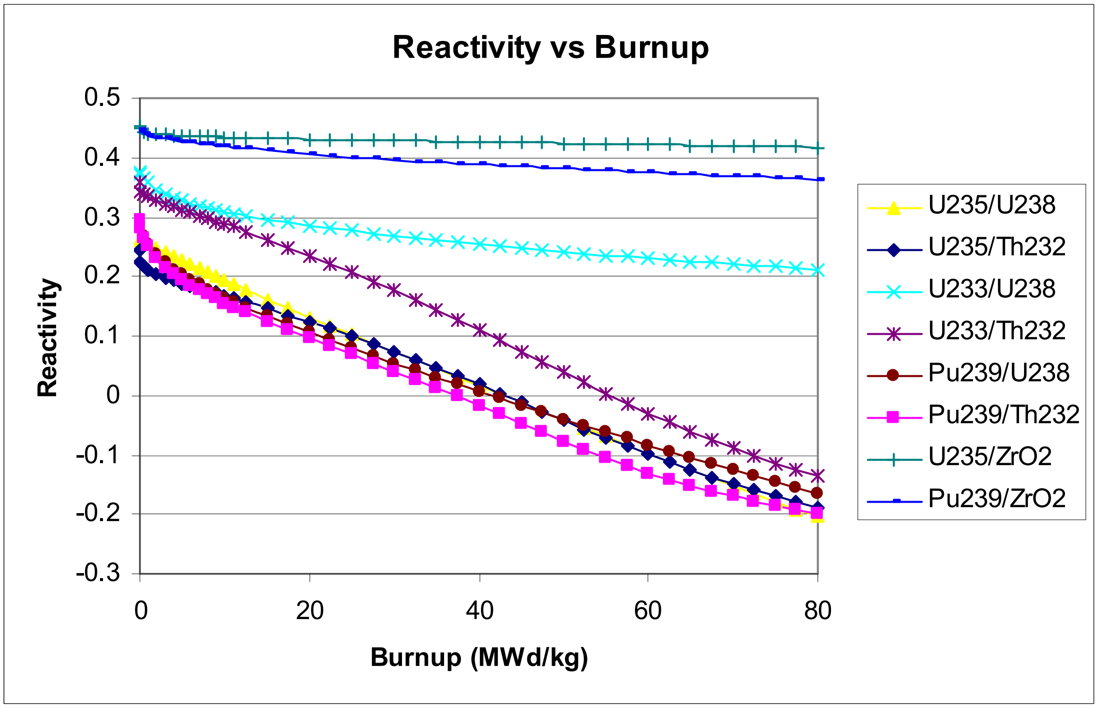
Lab 1 Solution
22.251
Fall 2005

Part a)



Case	B_1 (MWd/kg)
Sample	37.5
1	37.5
2	>80
3	50
4	35
5	30
6	>80
7	>80

Part b)

There are a few things to consider in explaining the behavior of these plots:

- The initial drop in reactivity is due to the accumulation of fission product neutron poisons (primarily Xe and Sm) reaching their equilibrium values.
- K-inf (and hence reactivity), is given by $k_\infty = \frac{\nu\Sigma_f}{\Sigma_a}$. The fissile species dominates the fission cross, section, while all materials in the fuel determine the

absorption cross section. Additionally, the fertile species (if present) is transmuted into an additional fissile species. The important data to consider are:

Isotope	ν	σ_f (barns)	σ_a (barns)	η	Resonance Intergral
U233	2.492	531.1	578.8	2.287	
U235	2.418	582.2	680.8	2.068	
Pu239	2.871	742.5	1011.3	2.108	
Th232	-	-	7.4	-	85
U238	-	-	2.7	-	244
Zr	-	-	0.184	-	
O	-	-	7.18E-5	-	

Note: These data are for a thermal spectrum.

Some additional considerations are:

- Burnup is defined as MWd per initial ton of <u>heavy metal</u>. When the fertile species in a fuel is replaced by an inert matrix, the burnup will significantly increase for a given energy output.
- A strong absorber, like Pu239, will tend to harden the neutron spectrum, which will result in a slighty higher rate of fast fissions in the fertile isotopes.
- U238 breeds fissile material faster than Th232, because of the decay half-lives involved, and the fact that U238 has a large resonance integral.
- However, Th232 is preferred for thermal breeder applications because of the large value of η for U233.