APAM 4010 SOLUTIONS #9

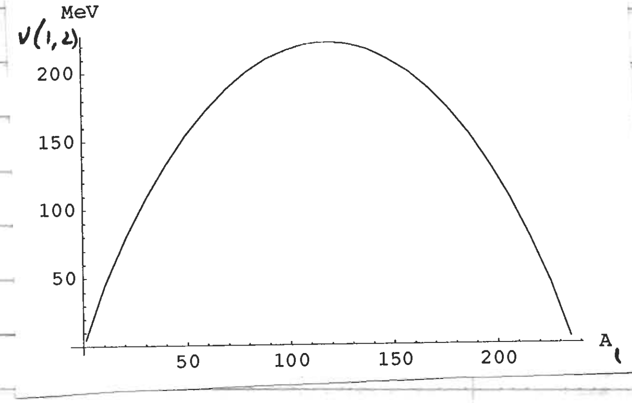
PROBLEM #1

$$V(1,2) = \frac{1}{4\pi\epsilon_0} \frac{Z_1 Z_2 e^2}{(R_1 + R_2)}$$

BUT $Z_1 = \frac{92}{236} A_1 \qquad Z_2 = 92 - Z_1$ AND $A_2 = 236 - A_1$

THUS

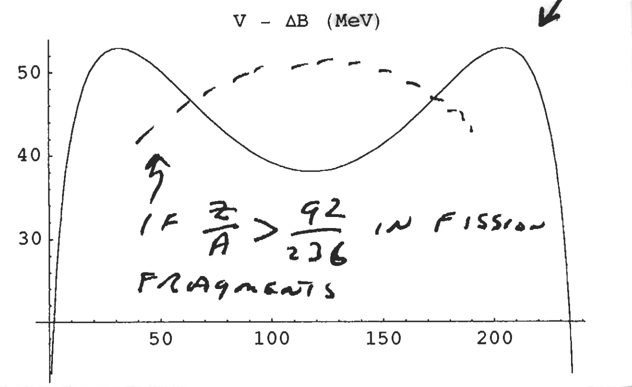
$$V(1,2) = \frac{1.44\ \text{MeV}}{1.4} \frac{Z_1 Z_2}{(A_1^{1/3} + A_2^{1/3})}$$



THE POTENTIAL BARRIER ~~FOR~~ AGAINST FISSION IS VERY HIGH.

THE POTENTIAL BARRIER IS ALSO SMALLER WHEN THE FRAGMENTS ARE NOT EQUAL IN SIZE. THIS SUGGESTS A POSSIBLE REASON FOR THE (SLOW) NEUTRON FISSION FRAGMENT DISTRIBUTION SHOWN IN FIG. 10-2. BUT, IT IS COMPLICATED! FOR EXAMPLE, IF WE USE THE SEMF, WE CAN CALCULATE THE ENERGY RELEASED AS A FUNCTION OF THE MASS SPLIT:

THE DIFFERENCE BETWEEN ENERGY RELEASED AND COULOMB BARRIER IS MINIMUM AT AN EQUAL SPLIT.



BUT IF WE ALLOW FREE NEUTRONS IN ADDITION TO THE FISSION FRAGMENTS (i.e. $\frac{Z}{A} \neq \frac{92}{236}$), THEN EQUAL SPLITS PREVENTED

PROBLEM #2

$$d + d \rightarrow n + {}^3He + Q$$

$$Q = 2m_d - m_n - M({}^3He)$$
$$= 2 \times 14102 - 8665 - 16029 \times 10^{-6} \times 931.5 \text{ MeV/amu}$$
$$= 3.269 \text{ MeV}$$

$$E_N = \frac{P_N^2}{2m_N} ; \quad E_{He} = \frac{P_{He}^2}{2M_{He}}$$ BUT $P_N = P_{He}$ SO

$$E_{He} = E_N \left(\frac{M_n}{M_{He}}\right) ; \quad Q = E_{He} + E_N$$

$$E_N = Q \Big/ \left(1 + \frac{m_N}{m_{He}}\right) = 2.45 \text{ MeV}$$

$$E_{He} = 0.82 \text{ MeV}$$

$$d + d \rightarrow p + T + Q$$
$$Q = 2m_d - m_n - M(T)$$
$$= 2 \times 14102 - 7825 - 16029$$
$$= 4.052 \text{ MeV}$$

AND $$E_p = \frac{Q}{\left(1 + \frac{m_p}{m_T}\right)} = 3.04 \text{ MeV} \quad E_T = 1.015 \text{ MeV}$$