

1.a Nuclear binding energy per nucleon

$${}^{56}\text{Fe}: B/A = \frac{1}{A} (\Delta_H \cdot 26 + \Delta_n \cdot 30) = 8.79 \text{ MeV}$$

$${}^{238}\text{U}: 7.57 \text{ MeV}$$

1.b Total binding energy per nucleon of ${}^{56}\text{Fe} + 182n$

~~$$\frac{B_{\text{total}}}{A} = \frac{B_{{}^{56}\text{Fe}} \cdot 56 + 182 \cdot 0}{56 + 182} =$$~~

(only ${}^{56}\text{Fe}$ has binding energy) (but all nucleons count)

$$\frac{B_{\text{total}}}{A_{\text{total}}} = \frac{B_{{}^{56}\text{Fe}} \cdot 56}{56 + 182} = 2.07 \text{ MeV}$$

so the process increases B/A from 2.07 MeV to 7.57 MeV

1.c $Q = \Delta_{{}^{56}\text{Fe}} + 182 \Delta_n - \Delta_{{}^{238}\text{U}} = 1361 \text{ MeV}$ or $2.180 \cdot 10^{-3} \text{ erg}$

of ${}^{238}\text{U}$ nuclei in $10^{-5} M_{\odot}$ * :

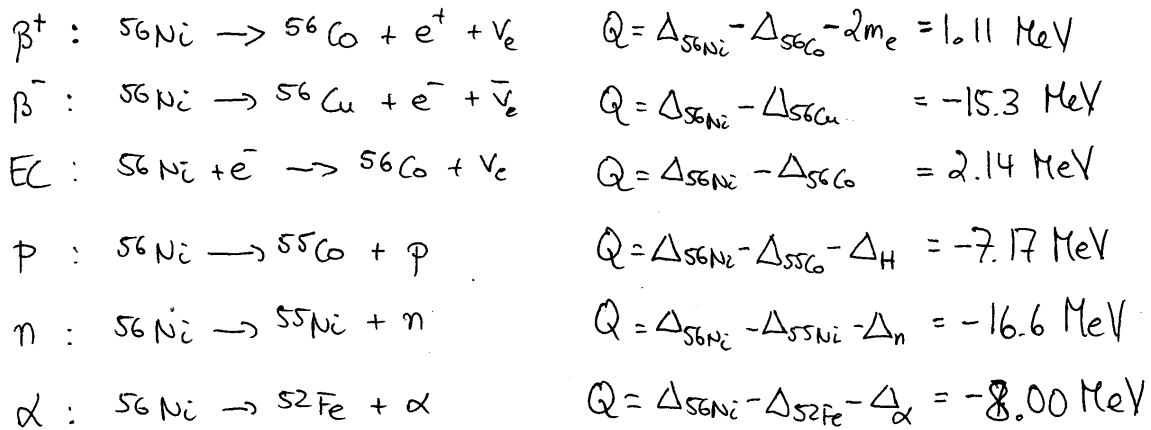
$$N_{{}^{238}\text{U}} = \frac{10^{-5} M_{\odot}}{\Delta_{{}^{238}\text{U}} + 238 \cdot m_u} = 5.04 \cdot 10^{49}$$

$$\text{total energy released} \therefore Q \cdot N_{{}^{238}\text{U}} = 1.10 \cdot 10^{47} \text{ erg}$$

which is much less than the 10^{53} erg of the SN

→ this does not contribute to the energetics

2. a/b



→ β^+ and EC are possible
EC dominates on earth

C. BE from Weizsäcker: 475 MeV

$$\text{So nuclear mass } M_{\text{nuc}} = \underset{\substack{\uparrow \\ \text{Proton mass} \\ 938.3 \text{ MeV}}}{m_p} \cdot 28 + \underset{\substack{\uparrow \\ \text{Neutron mass} \\ 939.565 \text{ MeV}}}{m_n} \cdot 28$$

$$\text{ⓐ } M_{\text{atomic}} \approx M_{\text{nuc}} + 28 \cdot m_e \quad (\text{neglecting electron binding energy!})$$

$$\Delta_{\text{atomic}} = \cancel{M_{\text{atomic}}} M_{\text{atomic}} - 56 \cdot m_u = -44.32 \text{ MeV}$$

d. this is almost 10 MeV off (only 0.02% of M_{nuc})

Weizsäcker is pretty precise for absolute masses
but not good enough to calculate Q-values
