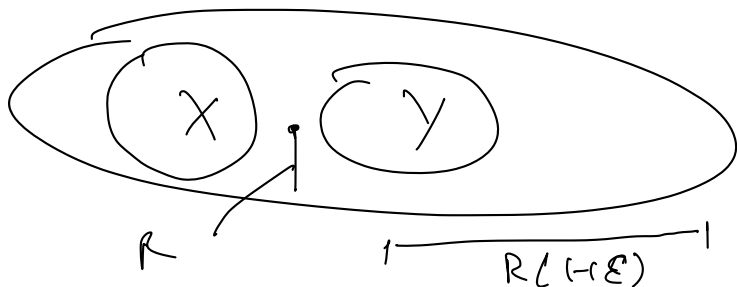
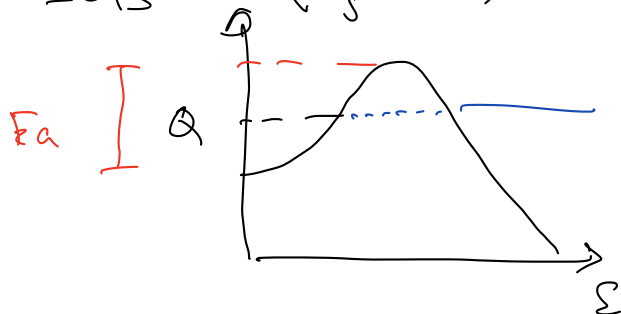


Token: 599 866



$${}^A_ZN \rightarrow X + Y + Q$$

$$\Delta B = -a_s A^{2/3} \left(\frac{2}{5} \epsilon^2 \right) - a_c Z^2 A^{1/3} \left(-\frac{1}{5} \epsilon^2 \right)$$



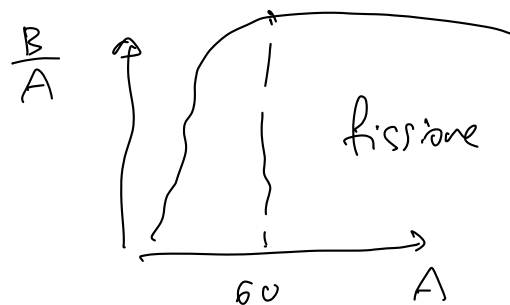
preferite : $\Delta B \approx 0$

$$Q > 0 \quad \Delta B \approx 0 \Rightarrow A \approx 200$$

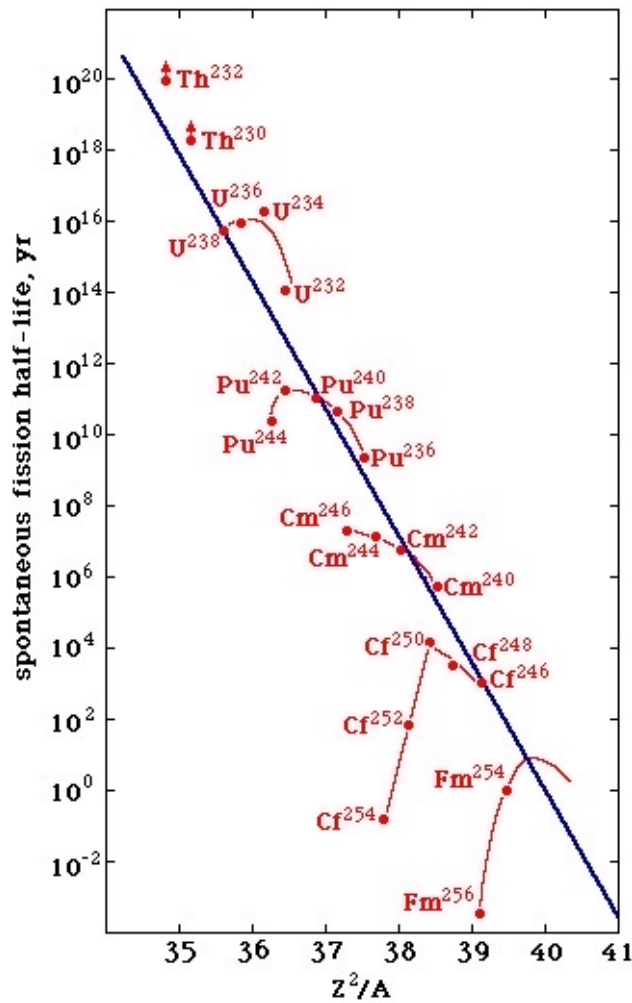
$A \approx 300$ $Q > E_a$ Spontane.

$A \approx 200$ favorito.

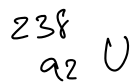
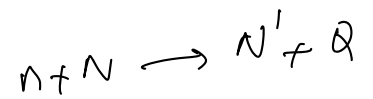
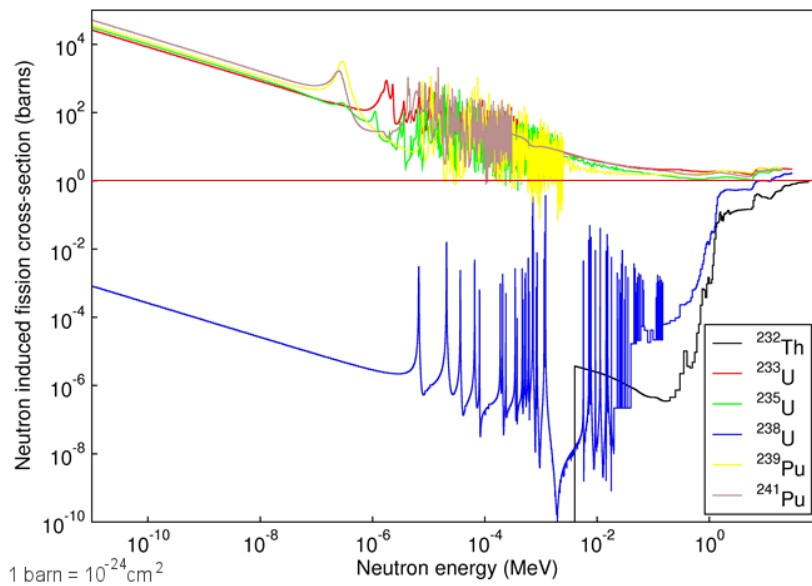
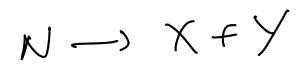
$A \approx 60$ $E_a - Q \approx 60 \text{ MeV}$ improbabile



$$\frac{\partial B}{\partial A} < 0$$



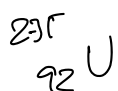
$T_{1/2}$



99.3%

$$Q = 4.8 \text{ MeV}$$

$$E_0 = 6.6 \text{ MeV}$$



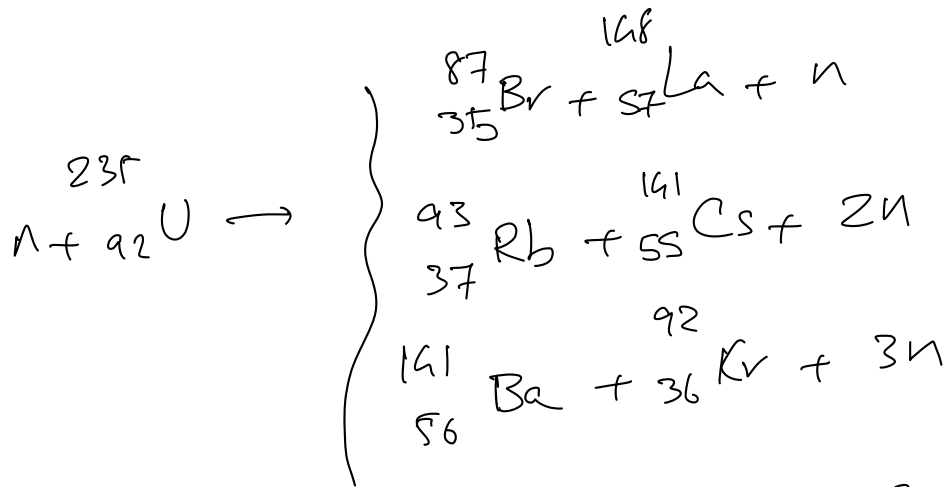
0.7%

$$Q = 6.5 \text{ MeV}$$

$$E_0 = 6.2 \text{ MeV}$$

$$\sigma (n + {}^{238}\text{U} \rightarrow {}^{239}\text{U}) \approx 0.5 \text{ b.} \quad K_n \approx 1.8 \text{ MeV}$$

$$\sigma (n + {}^{235}\text{U} \rightarrow {}^{236}\text{U}) \approx 580 \text{ b} \quad K_n \approx 0.025 \text{ eV}$$



in media $\langle \#n \rangle \approx 2.5 \quad Q \approx 200 \text{ MeV}$

$$\eta = \frac{Q}{M} \approx \frac{200 \text{ MeV}}{220 \text{ GeV}} \approx 10^{-3}$$

1g di uranio

$$Q = \frac{1}{235} \times 6 \times 10^{23} \times 200 \text{ MeV} = 5 \times 10^{23} \text{ MeV}$$

$\approx 10^{11} \text{ J} \quad \approx \times 3 \text{ en. prodotte dalla combustione di}$

1T di carbone

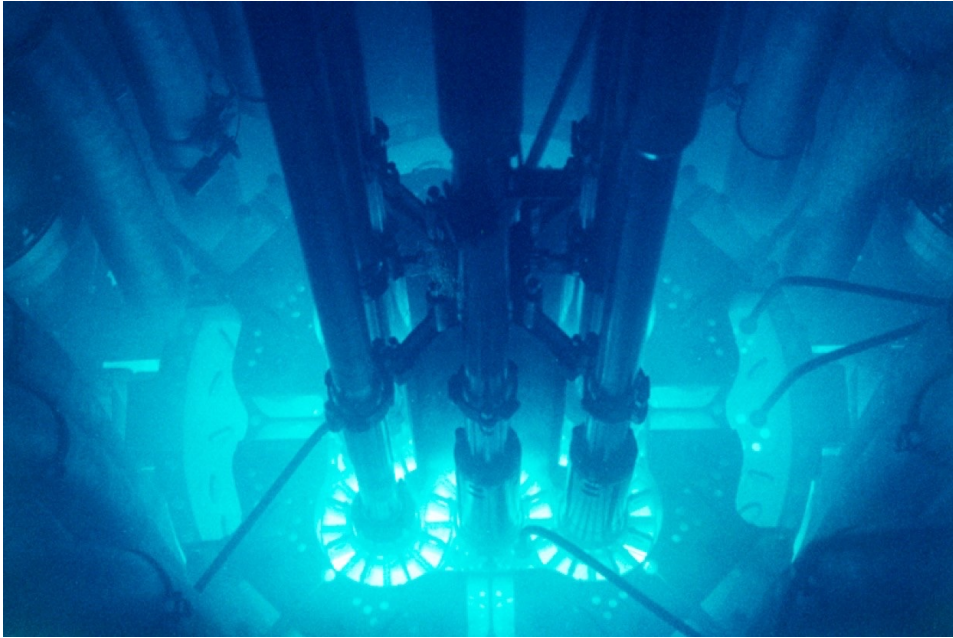
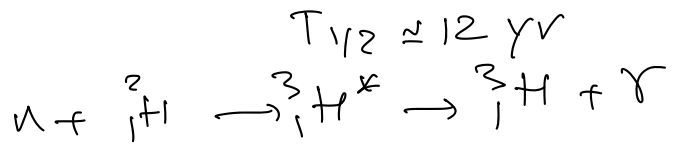
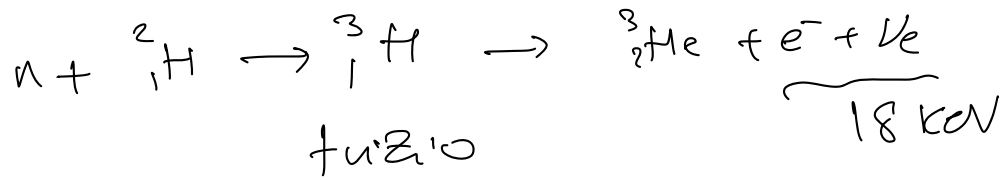


$$E_n' < E_n$$

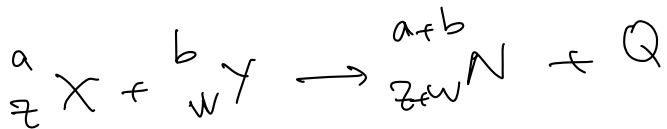


acque pesanti

ottimo assorbitore.

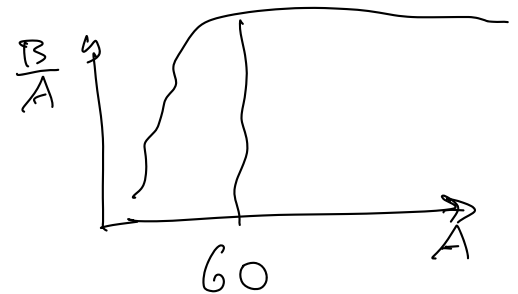


Fusione nucleare



$$\frac{\partial B}{\partial A} > 0$$

Ventilazione
per nuclei leggeri.



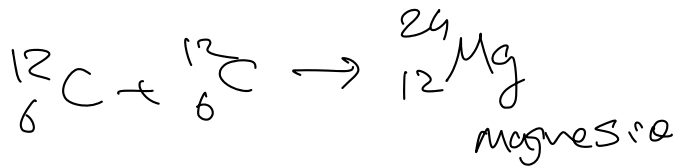
$$U(ZR) = \frac{e^2}{4\pi\epsilon_0} \frac{1}{2R_0} \approx \frac{\alpha}{2} \frac{1}{R_0}$$

$$R_v \approx 1 \text{ fm}$$

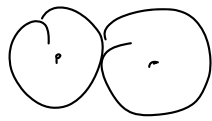
$$200 \text{ MeV fm} \approx 1 \Rightarrow 1 \text{ fm}^{-1} \approx 200 \text{ MeV}$$

$$U(2R) \approx 550 \text{ KeV}$$

En. cin. minime (w proton)
per tere fusione.



$$Q = 2M_c - M_{\text{mg}} = 13.9 \text{ MeV}$$

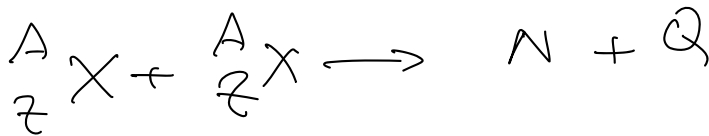
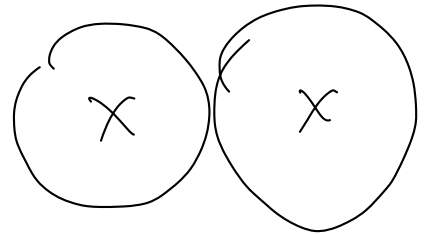


$$2R = 2R_0 A^{1/3}$$

$$U(2R) \approx 9 \text{ MeV}$$

$$Q' = 13.9 - 9 \approx 5 \text{ MeV netto}$$

$$\eta = \frac{Q'}{2M_c} = \frac{5 \text{ MeV}}{2 \times 11 \text{ GeV}} \approx 10^{-4}$$



$$U(R) = \frac{e^2}{4\pi\epsilon_0} Z^2 \frac{1}{2R}$$

$$= \frac{e^2}{4\pi\epsilon_0} \frac{Z^2}{2R_0 A^{1/3}} = \frac{\alpha}{2R_0} \frac{Z^2}{A^{1/3}}$$

$$\frac{Z}{A} \approx \frac{1}{2} \quad Z = \frac{A}{2} \Rightarrow U(R) \propto \frac{A^2}{A^{1/3}} \propto A^{5/3}$$

$$U(R) = (0.145 \text{ MeV}) A^{5/3}$$

$$\text{Helio } A=4, Z=2 \Rightarrow A^{5/3} \approx 10 \Rightarrow U \approx 1.45 \text{ MeV}$$

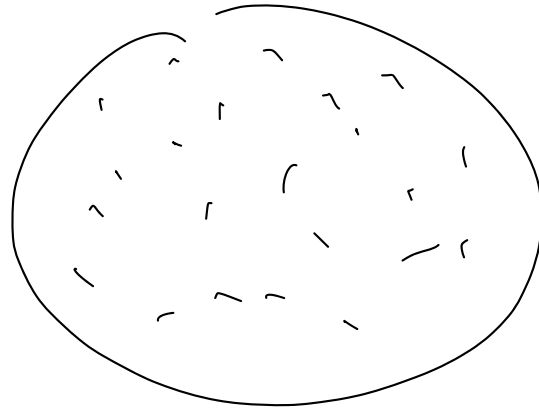
un gas di nuclei di massa $M(Z, A)$

$$kT = 145 \text{ KeV}$$

$$k = 8.6 \times 10^{-5} \text{ eV K}^{-1}$$

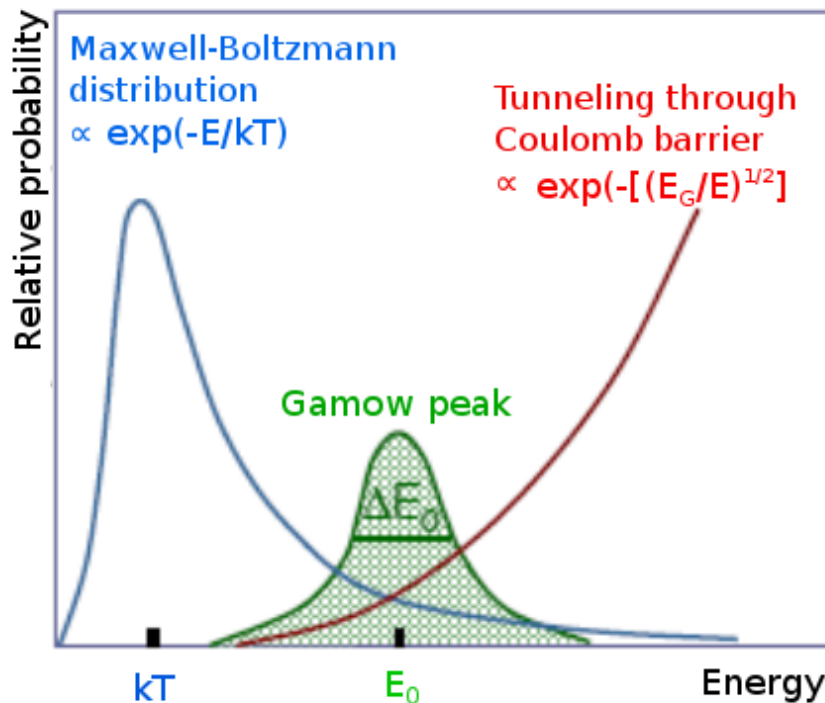
$$\Rightarrow T = 1.6 \times 10^9 \text{ K}$$

$$\langle E \rangle = \frac{3}{2} kT = \frac{1}{2} m \bar{v}^2$$



$$\frac{dn}{dv} = \frac{v^2}{(2\pi kT/m)^{3/2}} e^{-\frac{1}{2} \frac{mv^2}{kT}}$$

$$\bar{v} = \sqrt{\frac{3kT}{m}}$$



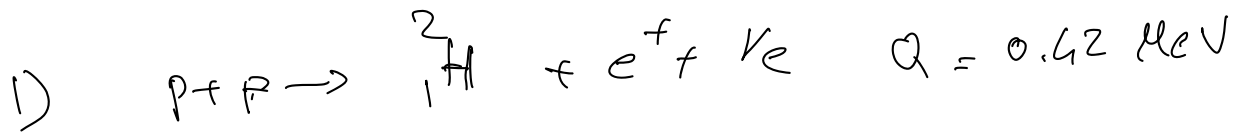
Fusione nelle stelle



$$\eta = \frac{26 \text{ MeV}}{3750 \text{ MeV}} = 7 \times 10^{-3}$$

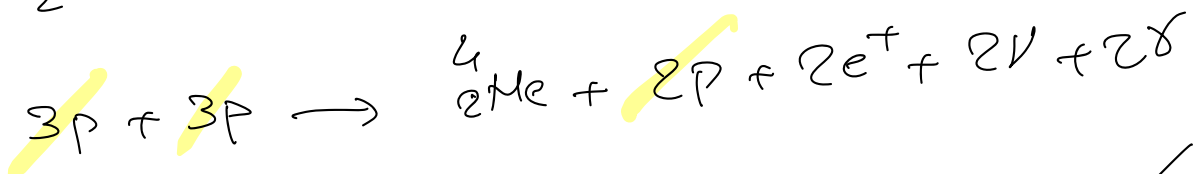
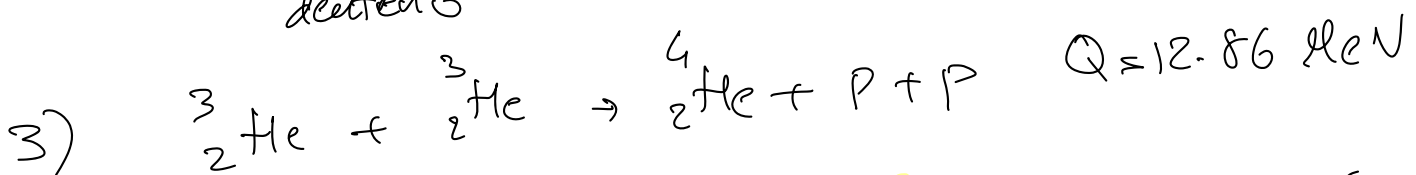
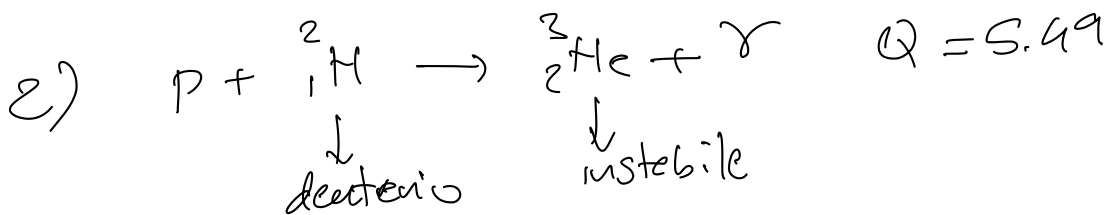
$$T_{\text{Sole}}^{\text{int}} = 1.5 \times 10^7 \text{ K} \Rightarrow \bar{E} = \frac{3}{2} kT = 190 \text{ KeV}$$

fusione possibile grazie
a Eff. tunnel e piccolo
di Gamow.



B	1	1	2	0	0
Le	0	0	0	-1	+1
Q	+1	+1	+1	+1	0

processo med. de mt debole $\sigma \approx 10^{-55} \text{ cm}^2$
 $\sigma \approx 10^{-31} \text{ b}$ $\tau_{SS} \approx 5 \times 10^9 \text{ yr}$

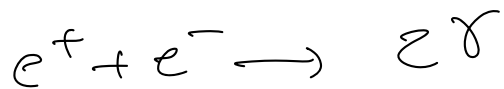


$$Q = 4m_p - m_\alpha - 2m_e - 2m_\nu$$

$$\approx 24.7 \text{ MeV}$$

$$\langle E_\nu \rangle \approx 0.3 \text{ MeV}$$

$$Q' = Q - 2 E_\nu \approx 24 \text{ MeV.}$$

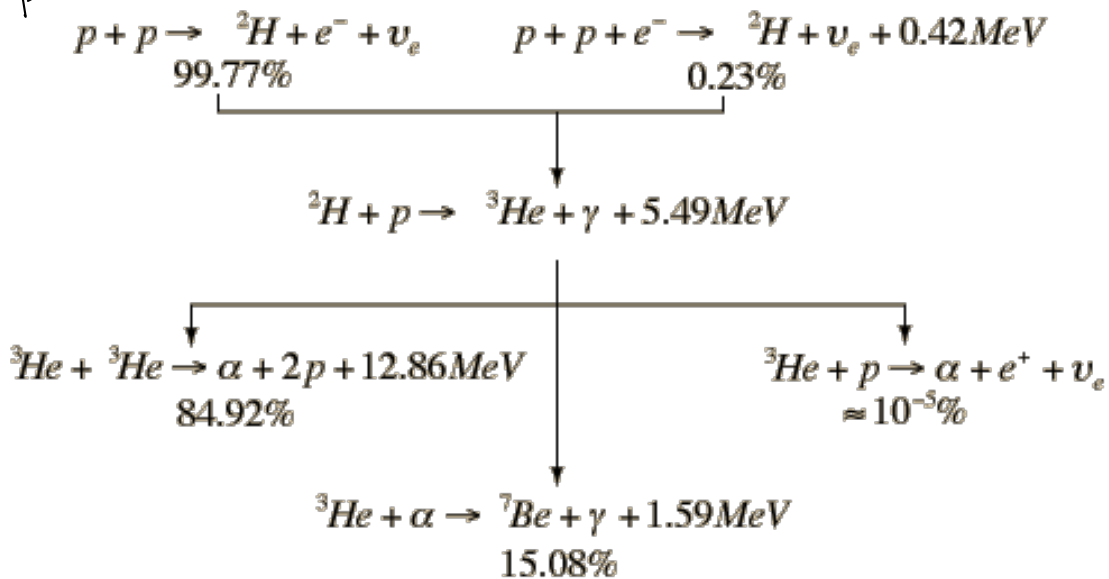


Ciascun positrone produce 2γ con $E \approx 1 \text{ MeV.}$

$$Q_{\text{netto}} = Q - 2 E_\nu + \underbrace{2 \times 1 \text{ MeV}}_{e^+} = 26 \text{ MeV}$$

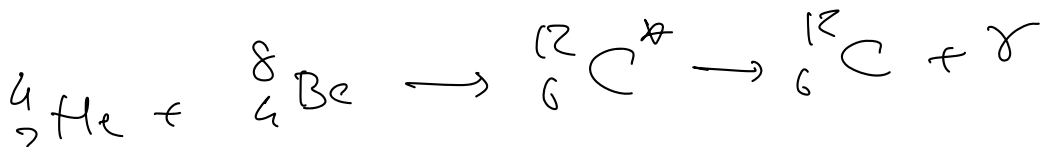
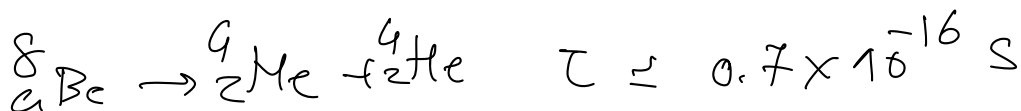
$$\eta = 0.007 \text{ rendimento.}$$

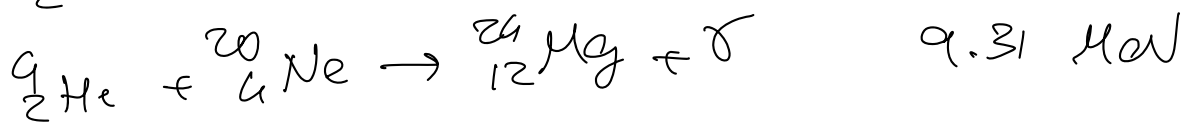
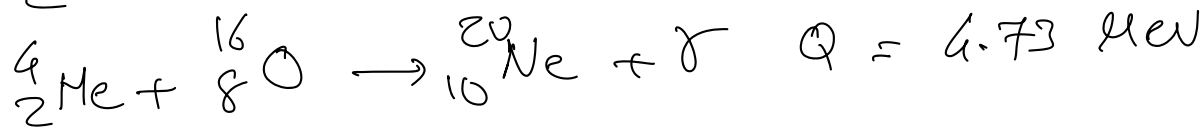
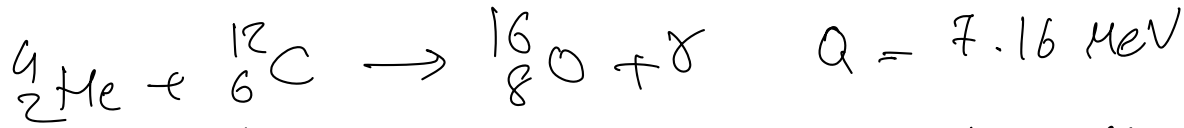
processo debole



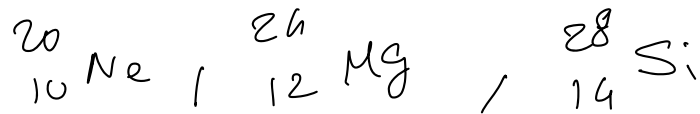
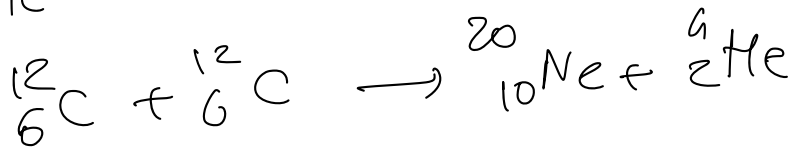
Nucleosintesi:

Si produce ${}^4_2\text{He}$ finché protoni esauriscono.





${}^4_2\text{He}$ esaucho \Rightarrow colleso \Rightarrow T avesso ulteriormente.



Si ferme per $\frac{\partial B}{\partial A} \approx 0 \Rightarrow A \approx 56$

1) catture neutronica.

2) $M > 1.5 M_{\odot}$

