894.

Problem 55.52 (RHK)

The most attractive fusion reactions for terrestrial use appear to be deuteron-deuteron (d-d) *and the deuteron-triton* (d-t) *reactions*:

d-d: $^2\mathrm{H} + {}^2\mathrm{H} \rightarrow {}^3\mathrm{He} + \mathrm{n} \quad (Q = +3.27\ \mathrm{MeV})$,

d-d: $^2\mathrm{H} + {}^2\mathrm{H} \rightarrow {}^3\mathrm{H} + {}^1\mathrm{H} \quad (Q = +4.03\ \mathrm{MeV})$,

d-t: $^2\mathrm{H} + {}^3\mathrm{H} \rightarrow {}^4\mathrm{He} + \mathrm{n} \quad (Q = +17.59\ \mathrm{MeV})$.

We have to verify the Q *values*. The *needed masses are*

^{1}H	1.007825 u	^{3}He	3.016029 u
^{2}H	2.014102 u	^{4}He	4.002603 u
^{3}H	3.016049 u	n	1.008665 u.

Solution:

The Q value for the reaction

d-d: $^2\mathrm{H} + {}^2\mathrm{H} \rightarrow {}^3\mathrm{He} + \mathrm{n}$

will be

$$= \left(2m_{^2\mathrm{H}} - m_{^3\mathrm{He}} - m_{\mathrm{n}}\right) \mathrm{u}c^2$$

$$= \left(2 \times 2.014102 - 3.016029 - 1.008665\right) \mathrm{u}c^2$$

$$= 0.00351\ \mathrm{u}c^2 = 0.00351 \times 931.5\ \mathrm{MeV}$$

$$= 3.269\ \mathrm{MeV}.$$

The Q value for the reaction

d-d: $^{2}\mathrm{H} + {}^{2}\mathrm{H} \rightarrow {}^{3}\mathrm{H} + {}^{1}\mathrm{H}$

will be

$$= \left(2m_{^{2}\mathrm{H}} - m_{^{3}\mathrm{H}} - m_{^{1}\mathrm{H}}\right) \mathrm{u}c^{2}$$

$$= \left(2 \times 2.014102 - 3.016049 - 1.007825\right) \mathrm{u}c^{2}$$

$$= 0.00433 \ \mathrm{u}c^{2} = 0.00433 \times 931.5 \ \mathrm{MeV}$$

$$= 4.03 \ \mathrm{MeV}.$$

The Q value for the reaction

d-t: $^{2}\mathrm{H} + {}^{3}\mathrm{H} \rightarrow {}^{4}\mathrm{He} + \mathrm{n}$

will be

$$= \left(m_{^{2}\mathrm{H}} + m_{^{3}\mathrm{H}} - m_{^{4}\mathrm{He}} - m_{\mathrm{n}}\right) \mathrm{u}c^{2}$$

$$= \left(2.014102 + 3.016049 - 4.002603 - 1.008665\right) \mathrm{u}c^{2}$$

$$= 0.018883 \ \mathrm{u}c^{2} = 0.018883 \times 931.5 \ \mathrm{MeV}$$

$$= 17.589 \ \mathrm{MeV}.$$