(10.11) In an experiment one hopes to produce the long-lived (2.6 y) ^{22}Na through a d,2n-reaction on neon. What is (a) the *Q*-value, (b) the threshold energy, (c) the Coulomb barrier height, and (d) the minimum deuteron energy for the reaction? The mass excesses (in keV) are -5185 for ^{22}Na and -8027 for ^{22}Ne.

$MeV := 1.60217733 \cdot 10^{-13} \cdot joule$ $amu := 1.6605402 \cdot 10^{-27} \cdot kg$

$M_n := 1.00866490 \cdot amu$ $M_d := 2.014102 \cdot amu$

$M_{Ne} := 22 \cdot amu - \frac{8.027 \cdot MeV}{931.5 \cdot \frac{MeV}{amu}}$ $M_{Na} := 22 \cdot amu - \frac{5.185 \cdot MeV}{931.5 \cdot \frac{MeV}{amu}}$

(a)

$Q := -931.5 \cdot \frac{MeV}{amu} \cdot \left(M_{Na} + 2 \cdot M_n - M_{Ne} - M_d\right)$ $Q = -9.371 \cdot 10^{-13} \cdot joule$ $Q = -5.849 \cdot MeV$

(b)

$E_{tr} := -Q \cdot \left(\frac{M_{Na} + M_d}{M_{Na}}\right)$ The () contains the recoil correction $E_{tr} = 6.384 \cdot MeV$

(c) $A_1 := 2$ $Z_1 := 1$ $A_2 := 22$ $Z_2 := 10$

$E_{cbmin} := 1.102 \cdot \left(A_1 + A_2\right) \cdot \frac{Z_1 \cdot Z_2}{A_2 \cdot \left(A_1^{\frac{1}{3}} + A_2^{\frac{1}{3}}\right)} \cdot MeV$ $E_{cbmin} = 2.96 \cdot MeV$

(d) Because E_{cbmin} is less than E_{tr} and the change in coulomb energy is included in *Q* we have:

$E_{proj} := E_{tr}$ $E_{proj} = 6.384 \cdot MeV$