(11.9) A 2 MeV neutron collides elastically with an iron atom (^{56}Fe). What is the average temperature (corresponding to the maximum velocity) which can be ascribed to the iron nucleus after the collision?

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

$E_n := 2 \cdot MeV \qquad M_{Fe} := 56 \cdot amu \qquad M_n := 1 \cdot amu$

$$V_n := \left(\frac{E_n}{\frac{1}{2} \cdot M_n}\right)^{\frac{1}{2}} \qquad V_n = 1.965 \cdot 10^{7} \cdot m \cdot sec^{-1}$$

Moment law:

$$V_n \cdot M_n = v_n \cdot M_n + v_{Fe} \cdot M_{Fe} \qquad v_n = V_n - \frac{v_{Fe} \cdot M_{Fe}}{M_n}$$

Energy law:

$$E_n = \frac{1}{2} \cdot M_n \cdot v_n^2 + \frac{1}{2} \cdot M_{Fe} \cdot v_{Fe}^2 \qquad E_n = \frac{1}{2} \cdot M_n \cdot \left(V_n - \frac{v_{Fe} \cdot M_{Fe}}{M_n}\right)^2 + \frac{1}{2} \cdot M_{Fe} \cdot v_{Fe}^2$$

$$v_{Fe} := \frac{1}{\left[2 \cdot \left(\frac{-1}{2} \cdot \frac{M_{Fe}^2}{M_n} - \frac{1}{2} \cdot M_{Fe}\right)\right]} \cdot \left(-V_n \cdot M_{Fe} - \sqrt{M_{Fe}} \cdot \frac{\sqrt{2 \cdot M_{Fe} \cdot E_n + 2 \cdot M_n \cdot E_n - M_n^2 \cdot V_n^2}}{\sqrt{M_n}}\right)$$

$$v_{Fe} := \frac{2 \cdot \sqrt{2 \cdot M_n \cdot E_n}}{M_n + M_{Fe}} \qquad v_{Fe} = 6.893 \cdot 10^{5} \cdot m \cdot sec^{-1}$$

This is non-relativistic

$$E_{Fe} := \frac{1}{2} \cdot M_{Fe} \cdot v_{Fe}^2$$

$$E_{Fe} := 4 \cdot \frac{M_{Fe} \cdot M_n}{\left(M_{Fe} + M_n\right)^2} \cdot E_n \qquad E_{Fe} = 0.138 \cdot MeV$$

Use: $E = 3\boldsymbol{k}T/2$:

$$k := 1.380658 \cdot 10^{-23} \cdot \frac{joule}{K} \qquad T_{Fe} := \frac{2 \cdot E_{Fe}}{3 \cdot k} \qquad T_{Fe} = 1.067 \cdot 10^{9} \cdot K$$