(12.1) (a) What kinetic energy must be given to a helium atom in order to increase its mass by 1%? (b) What are the mean velocity and the mean kinetic energy of a helium atom at STP?

First a definition of eV:

$eV := 1.60217733 \cdot 10^{-19} \cdot joule$

(a) Eqn. (12.7) can be rewritten as $E_{kin}=(m-m^0)*\mathbf{c}^2$ by using (12.5) and (12.6). If we convert to the amu scale the eqn. becomes $E_{kin}=931.5*\Delta M$ for E_{kin} in MeV and ΔM in u.

$\Delta M := \frac{1}{100} \cdot 4.002603$ This is 1% of the rest mass of a helium atom.

$E_{kin} := 931.5 \cdot \Delta M$ $E_{kin} = 37.3$ MeV

(b) From eqns (2.21) and (2.24) we obtain:

$k := 1.38066 \cdot 10^{-23} \cdot \frac{joule}{K}$ $T := 273.15 \cdot K$

$E_{mean} := \frac{3 \cdot k \cdot T}{2}$ $E_{mean} = 5.657 \cdot 10^{-21} \cdot joule$ or $E_{mean} = 0.035 \cdot eV$

$m_{He} := 4.002603 \cdot 1.660540 \cdot 10^{-27} \cdot kg$ $v_{mean} := \sqrt{\frac{2 \cdot E_{mean}}{m_{He}}}$

$v_{mean} = 1305 \cdot m \cdot sec^{-1}$