(10.1) (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?

(a) Eqn. (10.8) can be rewritten as $E_{kin}=(m-m^0)*c^2$ by using (10.6) and (10.7). 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.

$E_{kin} := 931.5\cdot \Delta M$ $E_{kin} = 37.284$ MeV

(b) From eqns (3.31) and (3.33) 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 $5.657\cdot 10^{-21}\cdot 6.24146\cdot 10^{18} = 0.035$ eV

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

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