9.13) a) FIND v_{RMS} FOR H_2 GAS AND N_2 GAS AT 293K.
b) USE THIS TO DISCUSS WHY EARTH'S ATMOSPHERE HAS N_2 NOT H_2.

TREATING EARTH'S ATMOSPHERE AS A CLASSICAL GAS,

$$v_{RMS} = \sqrt{\frac{3kT}{m}} \qquad (9.20)$$

FOR H_2: $m_{H_2} = 2(1.008u) = 2.02u\left(\frac{1.66\times10^{-27}\,kg}{u}\right)$

$$\underline{m_{H_2} = 3.35\times10^{-27}\,kg}$$

N_2: $m_{N_2} = 2(14.003u) = 28.006\left(\frac{1.66\times10^{-27}\,kg}{u}\right)$

$$\underline{m_{N_2} = 4.46\times10^{-26}\,kg}$$

THUS

$$v_{RMS,H_2} = \sqrt{\frac{3(1.38\times10^{-23}\,J/K)(293K)}{3.35\times10^{-27}\,kg}} \sim \frac{\frac{N\cdot m}{K}\cdot K}{kg} \sim \frac{\frac{kg\cdot m^2}{s^2}}{kg} \sim \frac{m^2}{s^2}$$

$$\boxed{v_{RMS,H_2} = 1902\ m/s}$$

$$v_{RMS,H_2} = \sqrt{\frac{3(1.38\times10^{-23})(293)}{4.46\times10^{-26}}}$$

$$\boxed{v_{RMS,N_2} = 510\ m/s}$$

b) FIND THE ESCAPE SPEED FOR EARTH

$$v_{E,E} = \sqrt{\frac{2GM_E}{R_E}} = \sqrt{\frac{2(6.67\times10^{-11})(5.97\times10^{24})}{(6.38\times10^{6})}}$$

$$v_{E,E} = 11,172\ \frac{m}{s} \Rightarrow v_{RMS,H_2} = 17\%\, v_{E,E}$$

$$v_{RMS,N_2} = 4\%\, v_{E,E}$$

SINCE THE AVERAGE H_2 IS AT 17% OF $v_{E,E}$, THERE WILL BE MANY H_2'S AT AND ABOVE ESCAPE SPEED, PARTICULARLY AFTER COLLISIONS WITH BIGGER N_2 MOLECULES!

$\Rightarrow$ H_2 MORE LIKELY TO ESCAPE THAN N_2.
$\Rightarrow$ N_2 REMAINS IN EARTH'S ATMOSPHERE