# HW#2 Solution

$$=6\times(\tfrac{1}{2}R)$$

18.44 (a) $C_V = 3R = 3\times 8.314\,J/mol\cdot K = 24.9\,J/mol\cdot K$

So the heat capacity is given by $\frac{C_V}{M} = \frac{24.9\,J/mol\cdot K}{1.8\times10^{-2}\,kg/mol} =$

$$= 1.383\times10^{3}\,J/kg\cdot K = 1383\,J/kg\cdot K$$

(b) the actual heat capacity $C = 2000\,J/kg\cdot K > 1383\,J/kg\cdot K$

$\cancel{\frac{C_V}{R} = \frac{2000\,J/kg\cdot K}{8.314}}$ $\frac{2000\times1.8\times10^{-2}}{8.314} = 4.33$

Vibrational motion contributes to the heat capacity of water vapor and also leads to additional degrees of freedom.

18.77 (a) $\underbrace{-G\frac{Mm}{R_p^2}\cdot R_p}_{U} + K > 0$

$$U = -G\frac{Mm}{R_p} \qquad G\frac{Mm}{R_p^2} = mg \rightarrow G\frac{M}{R_p^2} = g$$

$$GM = gR_p^2$$

$$= -\frac{gR_p^2 m}{R_p}$$

$$= -mgR_p$$

$$K > mgR_p$$

(b) kinetic energy of a nitrogen molecule is $\frac{3}{2}kT$

$\frac{3}{2}kT = mgR_e \rightarrow T = \frac{2mgR_e}{3k}$ $\quad g = 9.8\,m/s^2, \; R_e = 6.38\times10^6$

$m = \frac{M}{N_A} = \frac{28\times10^{-3}}{6.022\times10^{23}} = 4.65\times10^{-26}\,kg/mole$

For Nitrogen: $T = \frac{2}{3}\times\frac{4.65\times10^{-26}\,kg/molecule\times9.8\,m/s^2\times6.38\times10^{6}\,m}{1.381\times10^{-23}\,J/molecule} = \boxed{1.4\times10^{5}\,K}$

For Hydrogen: $T = \boxed{1.0\times10^{4}\,K}$

(c) $g = 1.63\,m/s^2$ $\quad R_p = 1.74\times10^{6}\,m$

For Nitrogen $T = \frac{2}{3}\times\frac{4.65\times10^{-26}\times1.74\times10^{6}\times1.63}{1.381\times10^{-23}} = \boxed{6350\,K}$

For Hydrogen $T = \frac{2}{3}\times\frac{3.354\times10^{-27}\times1.63\times1.74}{1.381\times10^{-23}} = \boxed{459K}$

Compared with the earth, the temperatures at which Nitrogen and Hydrogen escape ~~from~~ the moon are much lower. ~~Then~~ Since the earth and the moon have similar average surface temperatures, it is more easier for these gases to escape from the moon.