Quiz 8.2 – Gas Laws

Name: Key

Question 1

A weather balloon starts in Cedar City with with $P = 0.82\ atm$, $T = 21.5\ °C$, and $V = 18.75\ L$

$21.5 + 273 = 294.5\ K$

- Find the number of moles of gas inside the balloon

$n = \frac{PV}{RT} = \frac{0.82\ atm \cdot 18.75\ L}{0.0821\ \frac{L \cdot atm}{mol \cdot K} \cdot 294.5\ K} = 0.64\ moles$

- If the balloon is filled with He gas, find the mass of the gas inside the balloon

$0.64\ moles\ He \left| \frac{4.00\ g\ He}{1\ mol\ He} \right. = 2.56\ g = 2.6\ g$

- Find the density of the He-filled balloon (assume the instruments and balloon itself have no mass)

$d = \frac{m}{V} = \frac{2.56\ g}{18.75\ L} = 0.14\ \frac{g}{L} = 1.4 \cdot 10^{-4}\ g/mL$

- Find the density of the surrounding air (assume it is 100% N_2 gas)

$0.64\ moles\ N_2 \left| \frac{28.01\ g\ N_2}{1\ mol\ N_2} \right. = 17.9\ g\ N_2 \qquad d = \frac{17.9\ g}{18.75\ L} = 0.96\ \frac{g}{L} = 9.6 \cdot 10^{-4}\ g/mL$

Question 2

The weather balloon is released into the upper atmosphere and the instruments on-board indicate a pressure of $0.45\ atm$ and a temperature of $-32.4\ °C$ → $273 - 32.4 = 240.6\ K$

What will the new volume of the balloon be?

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \rightarrow V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{0.82\ atm \cdot 18.75\ L \cdot 240.6\ K}{294.5\ K \cdot 0.45\ atm} = 27.9\ L = 28\ L$

Question 3

A car engine burns about $0.1\ g$ of gasoline (C_8H_{18})for each engine cycle. A car engine may have a cylinder volume of $1.25\ L$, and operate at a temperature of $80.0\ °C$. If the gasoline combusts completely inside the $1.25\ L$ piston, what is the pressure of the combustion products?

$2\ C_8H_{18}(g) + 17\ O_2(g) \rightarrow 8\ CO_2(g) + 18\ H_2O(g)$

$2\ mol : 20\ mol$

$0.1\ g\ C_8H_{18} \left| \frac{1\ mol\ C_8H_{18}}{114.23\ g\ C_8H_{18}} \right. \left| \frac{20\ mol\ gas\ products}{2\ mol\ C_8H_{18}} \right. = 0.00875\ moles\ gas\ product$

$80.0 + 273 = 353\ K$

$P = \frac{nRT}{V} = \frac{0.00875\ moles \cdot 0.0821\ \frac{L \cdot atm}{mol \cdot K} \cdot 353\ K}{1.25\ L} = 0.2\ atm$