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 $V = 18.75\ L$

→ 294.5 K

- Find the number of moles of gas inside the balloon

$n = \frac{PV}{RT} = \frac{0.82\ atm \cdot 18.75\ L}{0.08206\ \frac{L \cdot atm}{mol \cdot K} \cdot 294.5\ K} = 0.64\ moles$

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

$0.636\ moles \left| \frac{4.003\ g\ He}{1\ mol\ He} \right. = 2.5\ g$

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

$d = \frac{mass}{volume} = \frac{2.55\ g}{18.75\ L} = 0.14\ g/L \rightarrow 1.4 \cdot 10^{-4}\ g/mL$

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

$0.636\ moles \left| \frac{28.01\ g\ N_2}{1\ mol\ N_2} \right. = 17.81\ g$ $\qquad \frac{17.81\ g}{18.75\ L} = 0.95\ g/L \rightarrow 9.5 \cdot 10^{-4}\ g/mL$

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 $-32.4\ °C$ → 240.6 K

What will the new volume of the balloon be?

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

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?

$2\ C_8H_{18}(g) + 25\ O_2(g) \rightarrow 16\ CO_2(g) + 18\ H_2O(g)$ $\qquad$ 2 moles C_8H_{18} → 34 moles product

$0.1\ g\ C_8H_{18} \left| \frac{1\ mol\ C_8H_{18}}{114.23\ g\ C_8H_{18}} \right| \frac{34\ moles\ product}{2\ mol\ C_8H_{18}} = 0.0149\ moles\ product$

80.0 °C → 353 K

$P = \frac{nRT}{V} = \frac{0.0149\ moles \cdot 0.08206\ \frac{L \cdot atm}{mol \cdot K} \cdot 353\ K}{1.25\ L} = 0.34\ atm$