Extra Problems – Unit 6 Gas Properties Mixed Up

1. A. How many moles of gas are in a 30 liter scuba canister if the temperature of the canister is 300 K and the pressure is 200 atmospheres? nothing Δ's

$PV = nRT$

$V = 30L$
$T = 300K$
$P = 200atm$
$n = ?(atm)$
$R = 0.0821$

$$n = \frac{PV}{RT} = \frac{200atm \cdot 30L}{300K \cdot 0.0821} = 243.6\ mol.$$

B. After 3 hours under water the number of moles decreases by ~~05~~ 60%. What is the new pressure inside the canister? Δing cond. initial | final

$V_1 = 30L$ $V_2 = 30L$
$T_1 = 300K$ $T_2 = 300K$
$P_1 = 200atm$ $P_2 = ?$
$n_1 = 243.6\ mol$ $n_2 = 97.44\ mol$

$n_1 = 243.6 \cdot (1-.6) = 97.44\ mol$

Initial: $\frac{P_1}{n_1} = \frac{RT}{V}$ Δ doesn't Δ

Final: $\frac{P_2}{n_2} = \frac{RT}{V}$ Δ doesn't Δ

$$\frac{P_1}{n_1} = \frac{P_2}{n_2}$$

$$P_2 = \frac{P_1 \cdot n_2}{n_1} = \frac{200atm \cdot 97.44mol}{243.6\ mol} = 80\ atm$$

2. A toy balloon has an internal pressure of 1.05 atm and a volume of 5.0 L. If the temperature where the balloon is released is 20^0 C, what will happen to the volume when the balloon rises to an altitude where the pressure is 0.65 atm and the temperature is -15^0 C? Δing cond. initial | final

$P_1 = 1.05atm$ $P_2 = 0.65atm$
$V_1 = 5.0L$ $V_2 = ?$
$T_1 = 20°C \rightarrow 293K$ $T_2 = -15°C \rightarrow 258K$

$$\frac{PV}{T} = nR$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1 \cdot P_2} = \frac{1.05atm \cdot 5L \cdot 258K}{293K \cdot 0.65atm} = 7.11\ L$$

3. If divers rise too quickly from a deep dive, they get a condition called "the bends" which is caused by the expansion of very small nitrogen bubbles in the blood due to decreased pressure. If the initial volume of the bubbles in a diver's blood is 15 mL and the initial pressure is 12.75 atm, what is the volume of the bubbles when the diver has surfaced to 1.00 atm pressure? Δing cond. initial | final

$PV = nRT$

$V_1 = 15mL$
$P_1 = 12.75atm$

$V_2 = ?$
$P_2 = 1atm$

$$P_1V_1 = P_2V_2$$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{12.75atm \cdot 15mL}{1atm} = 191.25\ mL$$

4. If I have a 50 liter container that holds 45 moles of gas at a temperature of 200^0 C, what is the pressure inside the container? nothing Δ's

$V = 50L$
$n = 45mol$
$-200°C \rightarrow 473K$
(atm)

$PV = nRT$

$$P = \frac{nRT}{V} = \frac{45mol \cdot 0.082 \cdot 473K}{50L} = 34.9\ atm$$

5. A bag of potato chips is packaged at sea level (1.00 atm) and has a volume of 315 mL. If this bag of chips is transported to Denver (0.775 atm), what will the new volume of the bag be?

Δing cond. initial | final

$P_1 = 1\ atm$ $\quad P_2 = 0.775\ atm$
$V_1 = 315\ mL$ $\quad V_2 = ?$

$PV = nRT$

$P_1V_1 = P_2V_2$

$V_2 = \frac{P_1V_1}{P_2} = \frac{1\ atm \cdot 315\ mL}{0.775\ atm} = 406.45\ mL$

6. It is not safe to put aerosol canisters in a campfire, because the pressure inside the canisters gets very high and they can explode. If I have a 1.0 liter canister that holds 2 moles of gas, and the campfire temperature is 1400^0 C, what is the pressure inside the canister?

nothing Δing

$V = 1\ L$
$n = 2\ mol$
$T = 1400^\circ C \rightarrow 1673\ K$
$P = ?\ (atm)$
$R = 6.082$

$PV = nRT$

$P = \frac{nRT}{V} = \frac{2\ mol \cdot 6.082 \cdot 1673\ K}{1\ L} = 274.7\ atm$

7. A Los Angeles class nuclear submarine has an internal volume of eleven million liters at a pressure of 1.250 atm. If a crewman were to open one of the hatches to the outside ocean while it was underwater (pressure = 15.75 atm), what be would the new volume of the air inside the submarine?

Δing cond. initial | final

$PV = nRT$

$V_1 = 11 \times 10^6\ L$
$P_1 = 1.25\ atm$

$V_2 = ?$
$P_2 = 15.75\ atm$

$P_1V_1 = P_2V_2$

$V_2 = \frac{P_1V_1}{P_2} = \frac{1.25\ atm \cdot 11 \times 10^6\ L}{15.75\ atm} = 873{,}000\ L$

8. I have a balloon that can hold 100 liters of air at STP. If I place the balloon in a freezer and the volume decreases to 80 liters, what is the temperature of the balloon?

Δing cond. initial | final

$STP = 0^\circ C$ & $1\ atm$

$V_1 = 100\ L$
$T_1 = 0^\circ C \rightarrow 273\ K$
$P_1 = 1\ atm$

$V_2 = 80\ L$
$T_2 = ?$
$P_2 = 1\ atm$

$\frac{V}{T} = \frac{nR}{P}$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$T_2 = \frac{V_2T_1}{V_1} = \frac{80\ L \cdot 273\ K}{100\ L} = 218.4\ K$