Combined Gas Law Problems

1) **A sample of sulfur dioxide occupies a volume of 652 mL at 40.° C and 720 mm Hg. What volume will the sulfur dioxide occupy at STP?**

2) **A sample of argon has a volume of 5.0 dm^3 and the pressure is 0.92 atm. If the final temperature is 30.° C, the final volume is 5.7 L, and the final pressure is 800. mm Hg, what was the initial temperature of the argon?**

3) **322 L of hydrogen occupies a volume of 197 L at STP. What was the initial pressure exerted on the hydrogen?**

4) **The initial temperature of a 1.00 liter sample of argon is 20.° C. The pressure is decreased from 720 mm Hg to 360 mm Hg and the volume increases to 2.14 liters. What was the change in temperature of the argon?**

5) **A sample of nitrogen gas occupies a volume of 2.00 L at 756 mm Hg and 0.00° C. The volume increases by 2.00 L and the temperature decreases to 137 K. What is the final pressure exerted on the gas?**

6) **A 20. L container is filled with helium and the pressure is 150 atm and the temperature is 30.° C. How many 5.0 L balloons can be filled when the temperature is 22° C and the atmospheric pressure is 755 mm?**

Solutions

1) $P_1 = 720$ mm $\qquad P_2 = 760$ mm

$V_1 = 652$ mL $\qquad V_2 = ?$

$T_1 = 40.°$ C + 273 = 313 K $\qquad T_2 = 0°$ C + 273 = 273 K

$P_1V_1/T_1 = P_2V_2/T_2$

$V_2 = P_1V_1/T_1 \times T_2/P_2$

$V_2 = 720\ \cancel{\text{mm}} \times 652\ \text{mL} \times 273\ \cancel{\text{K}}/(313\ \cancel{\text{K}} \times 760\ \cancel{\text{mm}}) =$ 540 mL SO_2

2) $P_1 = 0.92$ atm $\qquad P_2 = 800.$ mm

$V_1 = 5.0\ \text{dm}^3$ $\qquad V_2 = 5.7$ L

$T_1 = ?$ $\qquad T_2 = 30.°$ C + 273 = 303 K

$P_1V_1/T_1 = P_2V_2/T_2$

$T_1 = P_1V_1/P_2 \times T_2/V_2$

$T_1 = 0.92\ \cancel{\text{atm}} \times 760\ \cancel{\text{mm}}/1\ \cancel{\text{atm}} \times 5.0\ \cancel{\text{dm}}^3 \times 303\ \text{K}/(800.\ \cancel{\text{mm}} \times 5.7\ \cancel{\text{L}} \times 1\ \cancel{\text{dm}}^3/\cancel{\text{L}}) =$

232 K = -41° C

3) $P_1 = ?$ $\qquad P_2 = 1.00$ atm

$V_1 = 322$ L $\qquad V_2 = 197$ L

$T_1 = 37°$ C + 273 = 310 K $\qquad T_2 = 0°$ C + 273 = 273 K

$P_1V_1/T_1 = P_2V_2/T_2$

$P_1 = P_2V_2/T_2 \times T_1/V_1$

$P_1 = 1.00\ \text{atm} \times 197\ \cancel{\text{L}} \times 310\ \cancel{\text{K}}/(273\ \cancel{\text{K}} \times 322\ \cancel{\text{L}}) =$ 0.69 atm

4) $P_1 = 720$ mm $P_2 = 360$ mm

$V_1 = 1.00$ L $V_2 = 2.14$ L

$T_1 = 20.°$ C + 273 = 293 K $T_2 = ?$

$P_1V_1/T_1 = P_2V_2/T_2$

$T_2 = P_2V_2/P_1 \times T_1/V_1$

$T_2 = 360\ \cancel{\text{mm}} \times 2.14\ \cancel{\text{L}} \times 293\ \text{K}/(720\ \cancel{\text{mm}} \times 1.0\ \cancel{\text{L}}) =$ 313 K = 40.° C

5) $P_1 = 756$ mm $P_2 = ?$

$V_1 = 2.00$ L $V_2 = 4.00$ L

$T_1 = 0.0°$ C + 273 = 273 K $T_2 = 137$ K

$P_1V_1/T_1 = P_2V_2/T_2$

$P_2 = P_1V_1/T_1 \times T_2/V_2$

$P_2 = 756\ \text{mm} \times 2.00\ \cancel{\text{L}} \times 137\ \cancel{\text{K}}/(273\ \cancel{\text{K}} \times 4.00\ \cancel{\text{L}}) =$ 190. mm Hg

6) $P_1 = 150$ atm $P_2 = 755$ mm

$V_1 = 20.$ L $V_2 = ?$

$T_1 = 30.°$ C + 273 = 303 K $T_2 = 22°$ C + 273 = 295 K

$P_1V_1/T_1 = P_2V_2/T_2$

$V_2 = P_1V_1/T_1 \times T_2/P_2$

$P_2 = 150\ \cancel{\text{atm}} \times 20.\ \text{L} \times 295\ \cancel{\text{K}}/(303\ \cancel{\text{K}} \times 755\ \cancel{\text{mm}} \times 1\ \cancel{\text{atm}}/760\ \cancel{\text{mm}}) = 2940\ \text{L}$

balloons = 1 balloon/5.0 ~~L~~ x 2940 ~~L~~ = 588 balloons