

Steps for Solving General Gas Law Problems

1. Organize given information (P= , V= , etc.)
2. Identify the unknown variable
3. Use conversions to make units the same as the units of the gas constant R (frequently R=0.0821 L-atm/K-mol is used for the gas constant)

Useful Conversions:

- Pressure: 1.00 atm = 760 mmHg
 - Volume: 1 L = 10³ mL = 10⁶ μL, etc.
 - Temperature: K = °C + 273
 - Moles: 1 mole = grams of compound (molar mass), 1 mole = 6.022 X 10²³ molecules
4. Solve PV = nRT for the unknown variable
 5. Plug numbers into the rearranged equation and calculate Remember to record the correct number of significant figures and ensure that units cancel out.

Steps for Solving Change of State Gas Problems

1. Organize given information into State #1 and State #2
2. Identify the unknown variable
3. Use conversions to make units of pressure and volume consistent between states, remembering to always change temperature units to Kelvin. (See “Useful Conversions” above)
4. Solve $P_1V_1/n_1T_1 = P_2V_2/n_2T_2$ for the unknown variable
5. Plug numbers into the rearranged equation and calculate. Remember to record the correct number of significant figures and ensure that units cancel out.

Worked Example Using Strategy

Problem #1: 1.21 grams of CO₂ gas occupies 897 mL at 40°C. What is the pressure in mmHg?

1. $n = (1.21 \text{ g}) \times (1 \text{ mol}/44.01 \text{ g}) = 0.0275 \text{ mol}$
 $V = 897 \text{ mL} = 0.897 \text{ L}$
 $T = 40 + 273 = 313 \text{ K}$
2. P = ?
3. Units converted in part 1
4. $PV = nRT \rightarrow P = nRT/V$
5. $P = (0.0275 \text{ mol})(R=0.0821 \text{ L-atm/K-mol})(313 \text{ K})/(0.897 \text{ L}) = 0.788 \text{ atm} \times (760 \text{ mmHg}/1 \text{ atm}) =$
599 mmHg

Problem #2: What is the volume in mL of the gas in Problem #1 at STP? (STP is 0 °C and 1.00 atm)

1. State #1

$$n_1 = 0.0275 \text{ mol}$$

$$V_1 = 0.875 \text{ L}$$

$$T_1 = 313 \text{ K}$$

$$P_1 = 0.788 \text{ atm}$$

State #2

$$n_2 = 0.0275 \text{ mol (it is a closed system, so } n_1 = n_2)$$

$$V_2 = ?$$

$$T_2 = 0 \text{ °C} = 273 \text{ K}$$

$$P_2 = 1.00 \text{ atm}$$

2. V_2 is the unknown variable

3. Units match up and temperatures are in K

4. $P_1 V_1 / n_1 T_1 = P_2 V_2 / n_2 T_2 \rightarrow P_1 V_1 / T_1 = P_2 V_2 / T_2$ (because $n_1 = n_2$)

$$\rightarrow V_2 = P_1 V_1 T_2 / T_1 P_2$$

5. $V_2 = (0.788 \text{ atm})(0.875 \text{ L})(273 \text{ K}) / (313 \text{ K})(1.00 \text{ atm}) = 0.601 \text{ L} = \mathbf{601 \text{ mL}}$