

Answers to Gas Laws Practice Problems

1. molar mass of $\text{Cl}_2 = 2(35.45) = 70.90 \text{ g/mole}$

$$d = \frac{mm}{mV} = \frac{70.9 \text{ g}}{22.4 \text{ L}} = 3.17 \text{ g/L}$$

2. Molar volume is the volume when $n = 1.00 \text{ mole}$.

$$V = ?; n = 1.00 \text{ mol}; T = 78^\circ\text{C} + 273 = 351 \text{ K}; P = 1.20 \text{ atm}$$

$$V = \frac{nRT}{P} = \frac{(1.00 \text{ mol})(0.08206)(351 \text{ K})}{1.20 \text{ atm}} = 24.0 \text{ L}$$

3. $V_1 = 6.66 \text{ L}$; STP: $T_1 = 0^\circ\text{C} = 273 \text{ K}$; $P_1 = 1.00 \text{ atm} = 760 \text{ torr}$;

$$T_2 = 546^\circ\text{C} + 273 = 819 \text{ K}; P_2 = 684 \text{ torr}; V_2 = ?$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad V_2 = V_1 \times \frac{P_1}{P_2} \times \frac{T_2}{T_1} = 6.66 \text{ L} \times \frac{760 \text{ torr}}{684 \text{ torr}} \times \frac{819 \text{ K}}{273 \text{ K}} = 22.2 \text{ L}$$

4. mass of $\text{CO}_2 = ?$; $V = 5.60 \text{ L}$; $T = 273 \text{ K}$; $P = 2.00 \text{ atm}$

$$n = \frac{PV}{RT} = \frac{(2.00 \text{ atm})(5.60 \text{ L})}{(0.08206)(273 \text{ K})} = 0.500 \text{ moles}; 0.500 \text{ moles} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mole CO}_2} = 22.0 \text{ g CO}_2$$

5. From the Table, $P_{\text{H}_2\text{O}}$ at $21^\circ\text{C} = 19 \text{ mm Hg}$; You can subtract in atm or torr.

$$\text{For torr: } P_T = 1.02 \text{ atm} \times \frac{760 \text{ torr}}{1 \text{ atm}} = 775 \text{ torr}; P_{\text{N}_2} = P_T - P_{\text{H}_2\text{O}} = 775 - 19 = 756 \text{ torr}$$

$$\text{For atm: } P_{\text{H}_2\text{O}} = 19 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = 0.025 \text{ atm}; P_{\text{N}_2} = P_T - P_{\text{H}_2\text{O}} = 1.02 - 0.025 = 0.99 \text{ atm}$$

6. $P_{\text{N}_2} = 0.50 \text{ atm}$; $P_{\text{O}_2} = 0.30 \text{ atm}$; 28.0 g N_2 ; $n_T = ?$

$$P_T = P_{\text{N}_2} + P_{\text{O}_2} = 0.50 \text{ atm} + 0.30 \text{ atm} = 0.80 \text{ atm};$$

$$\text{moles N}_2 = 28.0 \text{ g N}_2 \times \frac{1 \text{ mole N}_2}{28.0 \text{ g N}_2} = 1.00 \text{ mol N}_2$$

$$P_{\text{N}_2} = \left(\frac{n_{\text{N}_2}}{n_T} \right) P_T \quad n_T = \left(\frac{P_T}{P_{\text{N}_2}} \right) n_{\text{N}_2} = \left(\frac{0.80}{0.50} \right) 1.00 \text{ mol} = 1.6 \text{ moles}$$

$$7. \text{ a) } 2.80 \text{ L} \times \frac{1 \text{ mole } O_2}{22.4 \text{ L } O_2} \times \frac{4 \text{ mole Na}}{1 \text{ mole } O_2} \times \frac{23.0 \text{ g Na}}{1 \text{ mole Na}} = 11.5 \text{ g Na}$$

b) First find molar volume at 25°C and 2.00 atm:

$$V = \frac{nRT}{P} = \frac{(1.00 \text{ mol})(0.08206)(298 \text{ K})}{2.00 \text{ atm}} = 12.2 \text{ L}$$

$$4.60 \text{ g Na} \times \frac{1 \text{ mole Na}}{23.0 \text{ g Na}} \times \frac{1 \text{ mole } O_2}{4 \text{ mole Na}} \times \frac{12.2 \text{ L } O_2}{1 \text{ mole } O_2} = 0.610 \text{ L } O_2$$

8. First find molar volume at 78°C and 1.20 atm. See problem 2: at 78°C and 1.20 atm, molar volume is 24.0 L/mole.

molar mass of ethane (C_2H_6) = 2(12.0) + 6(1.0) = 30.0 g/mole

$$d = \frac{mm}{mV} = \frac{30.0 \text{ g}}{24.0 \text{ L}} = 1.25 \text{ g/L}$$