Molar Volume and Gas Density

1. What is the volume, in liters, of each of the following at STP?
   a. 1.00 mol O_2 b. 0.0400 mol CO_2
   c. 3.50 mol F_2 d. 1.20 x 10^{-6} mol He

2. How many moles are contained in each of the following at STP?
   a. 22.4.L N_2 b. 5.60 L CO_2
   c. 0.125 L Ne d. 70.0 ml NH_3

3. Find the mass of each of the following at STP.
   a. 11.2 L H_2 b. 2.80 L CO_2
   c. 15.0 ml SO_2 d. 3.40 cm^3 F_2

4. Find the volume, in liters, of each of the following at STP.
   a. 8.00 g O_2 b. 3.50 g CO
   c. 0.0170 g H_2S d. 2.25 x 105 kg NH_3

5. Find the density of each of the following gases in grams per liter at STP.
   a. N_2 b. Cl_2 c. CO d. SO_2

6. Find the molar mass of each of the following at STP.
   a. 2.00 g and 1.50 L
   b. 3.25 g and 2.30 L
   c. 0.620 g and 250. ml

7. A sample of gas collected at 300.K and 740. mm Hg has a mass of 0.205 g and occupies a volume of 250. ml
   a. What volume would this gas occupy at STP?
   b. What is its molar mass?

8. A 6.51 m^3 container is filled with an unknown gas at 50. C and 840. mm Hg. The gas has a mass of 12.7 kg.
   a. Find the molar mass using the combined gas law.
   b. Among the gases listed below, which is likeliest to be the unknown gas -- H_2, O_2, N_2, CO_2 , or H_2S ?

9. Find the molar mass of a gas using the combined gas law if 850. ml of the gas collected over water at 650.0 mm Hg and 20.°C has a mass of 0.925 g.

10. A 500. cm^3 flask contains 0.750 g of a gas collected over water at 35 ℃ and 575.0 mm Hg. Used the combined gas law to find the molar mass of this gas.

1. Volume (L) at STP

a) $1.00\,mol\,O_2\left(\frac{22.41\,L}{1\,mol}\right) = 22.4\,L\,O_2$

b) $0.0400\,mol\,CO_2\left(\frac{22.41\,L}{1\,mol}\right) = 0.896\,L\,O_2$

c) $3.50\,mol\,F_2\left(\frac{22.41\,L}{1\,mol\,F_2}\right) = 78.4\,L\,F_2$

d) $1.20\times10^{-6}\,mol\,He\left(\frac{22.41\,L}{1\,mol\,He}\right) = 2.69\times10^{-5}\,L\,He$

2. moles at STP

a) $22.4\,L\,N_2\left(\frac{1\,mol\,N_2}{22.41\,L}\right) = 1.00\,mol\,N_2$

b) $5.60\,L\,CO_2\left(\frac{1\,mol\,CO_2}{22.41\,L}\right) = 0.250\,mol\,CO_2$

c) $0.125\,L\,Ne\left(\frac{1\,mol\,Ne}{22.41\,L}\right) = 0.00558\,mol\,Ne$

d) $70.0\,ml\left(\frac{1\,L}{1000\,ml}\right)\left(\frac{1\,mol\,NH_3}{22.41\,L}\right) = 0.00312\,mol\,NH_3$

3. mass at STP

a) $11.2\,L\,H_2\left(\frac{1\,mol\,H_2}{22.41\,L}\right)\left(\frac{2.02\,g\,H_2}{1\,mol\,H_2}\right) = 1.01\,g\,H_2$

b) $2.80\,L\,CO_2\left(\frac{1\,mol\,CO_2}{22.41\,L}\right)\left(\frac{44.01\,g\,CO_2}{1\,mol\,CO_2}\right) = 5.50\,g\,CO_2$

c) $15.0\,mol\,SO_2\left(\frac{1\,L\,SO_2}{1000\,mL}\right)\left(\frac{1\,mol\,SO_2}{22.41\,L}\right)\left(\frac{64.07\,g\,SO_2}{1\,mol\,SO_2}\right) = 0.0429\,g\,SO_2$

d) $3.40\,cm^3\,F_2\left(\frac{1\,ml}{1\,cm^3}\right)\left(\frac{1\,L}{1000\,ml}\right)\left(\frac{1\,mol\,F_2}{22.41\,L}\right)\left(\frac{38.00\,g\,F_2}{1\,mol\,F_2}\right) = 0.00577\,g\,F_2$

4. V(L) at STP

a) $8.00\,g\,O_2\left(\frac{1\,mol\,O_2}{32.00\,g\,O_2}\right)\left(\frac{22.41\,L\,O_2}{1\,mol\,O_2}\right) = 5.60\,L\,O_2$

b) $3.50\,g\,CO\left(\frac{1\,mol\,CO}{28.01\,g\,CO}\right)\left(\frac{22.41\,L}{1\,mol\,CO}\right) = 2.80\,L\,CO$

c) $0.0170\,g\,H_2S\left(\frac{1\,mol\,H_2S}{34.08\,g\,H_2S}\right)\left(\frac{22.41\,L}{1\,mol\,H_2S}\right) = 0.0112\,L\,H_2S$

d) $2.25\times10^5\,kg\,NH_3\left(\frac{1000\,g\,NH_3}{1\,kg}\right)\left(\frac{1\,mol\,NH_3}{17.03\,g\,NH_3}\right)\left(\frac{22.41\,L\,NH_3}{1\,mol\,NH_3}\right) = 2.96\times10^8\,L\,NH_3$

5. density (at STP)

a) $N_2 \rightarrow \frac{28.02\,g}{mol}\left(\frac{1\,mol\,N_2}{22.41\,L}\right) = 1.250\,\frac{g}{L}\,N_2$

b) $Cl_2 \rightarrow \frac{70.90\,g}{mol}\left(\frac{1\,mol\,Cl_2}{22.41\,L}\right) = 3.164\,\frac{g}{L}\,Cl_2$

c) $CO \rightarrow \frac{28.01\,g}{mol}\left(\frac{1\,mol\,CO}{22.41\,L}\right) = 1.250\,\frac{g}{L}\,CO$

d) $SO_2 \rightarrow \frac{64.07\,g}{mol}\left(\frac{1\,mol\,SO_2}{22.41\,L}\right) = 2.859\,\frac{g}{L}\,SO_2$

6. mm (at STP)

a) $\frac{2.00\,g}{1.50\,L}\left(\frac{22.41\,L}{1\,mol}\right) = 30.0\,\frac{g}{mol}$

b) $\frac{3.25\,g}{2.30\,L}\left(\frac{22.41\,L}{1\,mol}\right) = 31.7\,\frac{g}{mol}$

c) $\frac{0.620\,g}{0.250\,L}\left(\frac{22.41\,L}{1\,mol}\right) = 55.6\,\frac{g}{mol}$

7. $T_1 = 300.\,K$

$P_1 = 740.\,mmHg$

mass = 0.205 g

$V_1 = 250.\,ml$

$V_2 = ?$ $P_2 = 760.\,mmHg$ $T_2 = 273.15\,K$

a) V at STP? $V_2 = \frac{V_1 P_1 T_2}{T_1 P_2}$

$= \frac{(250.\,ml)(740.\,mmHg)(273.15\,K)}{(300.\,K)(760.\,mmHg)}$

$= 222\,ml$

b) mm? $\frac{0.205\,g}{222\,ml}\left(\frac{1000\,ml}{1\,L}\right)\left(\frac{22.41\,L}{1\,mol}\right) = 20.7\,\frac{g}{mol}$

8. $6.51\,m^3$

$T = 50.^\circ C + 273 \rightarrow 323\,K$

$P = 840.\,mmHg$

$12.7\,kg$

$6.51\,m^3\left(\frac{100\,cm}{1\,m}\right)^3\left(\frac{1\,ml}{1\,cm^3}\right) = 6.51\times10^6\,ml\left(\frac{1\,L}{1000\,ml}\right) = 6510\,L$

$V_2 = \frac{V_1 P_1 T_2}{T_1 P_2} = \frac{(6510\,L)(840.\,mmHg)(273.15\,K)}{(323\,K)(760.\,mmHg)}$

$= 6080\,L$

$\frac{12.7\,kg}{6080\,L}\left(\frac{22.41\,L}{1\,mol}\right)\left(\frac{1000\,g}{1\,kg}\right) = 44.0\,\frac{g}{mol}$ $= CO_2!$ $(44.0\,g/mol)$

9. mm? $V_1 = 850.\,ml$

$T_1 = 20.^\circ C + 273$

$P_{gas} = P_{atm} - P_{H_2O}$

$= 650.0\,mmHg - 17.5\,mmHg$

$= 632.5\,mmHg$

$V_2 = \frac{V_1 P_1 T_2}{T_1 P_2} = \frac{(850.\,ml)(632.5\,mmHg)(273.15\,K)}{(293\,K)(760.\,mmHg)}$

$= 650.\,ml\left(\frac{1\,L}{1000\,ml}\right)$

$\frac{0.925\,g}{0.650\,ml}\left(\frac{22.41\,L}{1\,mol}\right) = 31.9\,\frac{g}{mol}$

10. $V = 500.\ cm^3$

0.750 g

$T = 35^\circ C + 273.15 \rightarrow 308\ K$

$P = P_{atm} - P_{H_2O}$

$= 575.0\ mm\ Hg - 42.2\ mm\ Hg$

$= 532.8\ mm\ Hg$

$V_2 = \frac{V_1 P_1 T_2}{T_1 P_2}$

$= \frac{(500.\ cm^3)(532.8\ mm\ Hg)(273.15\ K)}{(308\ K)(760.\ mm\ Hg)}$

$= 311\ cm^3 \left(\frac{1\ L}{1000\ cm^3}\right) = 0.311\ L$

$\frac{0.750\ g}{0.311} \left(\frac{22.4\ L}{1\ mol}\right) = 54.0\ \frac{g}{mol}$