4. Silicon tetrafluoride gas can be produced by the action of HF on silica according to the following equation:

$$SiO_2\,(s) + 4HF\,(g) \rightarrow SiF_4\,(g) + 2H_2O\,(l)$$

1.00L of HF gas under a pressure of 3.48 atm and at a temperature of 25°C reacts completely with SiO_2 to form SiF_4. What volume of SiF_4, measured at 15°C and 0.940 atm is produced by this reaction?

① $V = 1.00\,L$, $P = 3.48\,atm$, $T = 298\,K$, $n = ?$

$PV = nRT$

$\frac{PV}{RT} = n$

$0.14\,mol = n_{HF}$

② $0.14\,mol\,HF \times \frac{1\,mol\,SiF_4}{4\,mol\,HF} = 0.036\,mol\,SiF_4$

③ $V = ?$, $T = 288\,K$, $P = 0.940\,atm$, $n = 0.036\,mol$

$PV = nRT$

$V = \frac{nRT}{P}$

$V = 0.94\,L$

5. Use the following reaction to answer question 5

$$2\,C_8H_{18(l)} + 25\,O_{2(g)} \rightarrow 16\,CO_{2(g)} + 18\,H_2O_{(g)}$$

The above reaction is the reaction between gasoline (octane) and oxygen that occurs inside automobile engines.

If 4.00 moles of gasoline are burned, what volume of oxygen is needed if the pressure is 0.953 atm, and the temperature is 35.0°C?

① $4.00\,mol\,C_8H_{18} \times \frac{25\,mol\,O_2}{2\,mol\,C_8H_{18}} = 50.0\,mol\,O_2$

② use $PV = nRT$ $P = 0.953\,atm$ $T = 308\,K$ $n = 50.0\,mol$ $R = 0.0821$ $V = ?$

$V = \frac{nRT}{P} = \frac{(50.0\,mol)(0.0821)(308\,K)}{0.953\,atm} = 1327\,L \rightarrow 1330\,L$

6. How many grams of NaCl can be produced by the reaction of 0.145 L of chlorine gas with excess sodium at a temperature of 27.0°C and 772 mmHg?

Write the balanced equation for the reaction below:

$Cl_2 + 2Na \rightarrow 2NaCl$

① $V = 0.145\,L$, $T = 300.K$, $P = 1.02\,atm$, $R = 0.0821$, $n = ?$

$n = \frac{PV}{RT}$

$n = 0.00600\,mol\,Cl_2$

② $0.00600\,mol\,Cl_2 \times \frac{2\,mol\,NaCl}{1\,mol\,Cl_2} \times \frac{58.44\,g\,NaCl}{1\,mol\,NaCl} = 0.702\,g\,NaCl$

NOTE → Pressure & temperature conversions are not shown to conserve space & to make key easier to read.

Also steps are numbered to show the order of operations

KEY

Gas Stoichiometry Practice

Use stoichiometry or a combination of the ideal gas law and stoichiometry to answer the questions (remember that 1 mole of gas = 22.4 L only at STP. Otherwise, ideal gas law must be used to find volume)

1) What volume of hydrogen at STP can be produced when 6.54 g of Zn reacts with hydrochloric acid, HCl?

$$Zn_{(s)} + 2\,HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$$

$$6.54\,g\,Zn \times \frac{1\,mol\,Zn}{65.38\,g\,Zn} \times \frac{1\,mol\,H_2}{1\,mol\,Zn} \times \frac{22.4\,L\,H_2}{1\,mol\,H_2} = \boxed{2.24\,L\,H_2}$$

2) Ethylene burns in oxygen to form carbon dioxide and water vapor:

$$C_2H_{4(g)} + 3\,O_{2(g)} \rightarrow 2\,CO_{2(g)} + 2\,H_2O_{(g)}$$

How many liters of water can be formed if 1.25 liters of ethylene are consumed in this reaction at a temperature of 25°C and a pressure of 760 torr?

① use $PV=nRT$ to find moles C_2H_4
② use stoichiometry to convert moles C_2H_4 to moles H_2O
③ Use $PV=nRT$ to find volume of H_2O

$V = 1.25\,L$
$T = 298\,K$
$P = 1\,atm$
$R = 0.0821$
$n = ?$

① $PV = nRT$

$\frac{PV}{RT} = n$

$\frac{(1\,atm)(1.25\,L)}{(0.0821)(298\,K)} = n$

$0.0511\,mol = n_{ethylene}$

② $0.0511\,mol\,C_2H_4 \times \frac{2\,mol\,H_2O}{1\,mol\,C_2H_4} = 0.102\,mol\,H_2O$

③ $V = ?$
$n = 0.102\,mol$
$P = 1\,atm$
$T = 298\,K$
$R = 0.0821$

$V = \frac{nRT}{P}$

$V = \frac{(.102\,mol)(0.0821)(298\,K)}{1\,atm}$

$\boxed{V = 2.50\,L}$

3) When chlorine is added to acetylene, 1,1,2,2-tetrachloroethane is formed:

$$2\,Cl_{2(g)} + C_2H_{2(g)} \rightarrow C_2H_2Cl_{4(l)}$$

How many liters of chlorine will be needed to make 75.0 grams of $C_2H_2Cl_4$ at 25°C and 101.325 kPa?

① $75.8\,g\,C_2H_2Cl_4 \times \frac{1\,mol\,C_2H_2Cl_4}{167.8\,g\,C_2H_2Cl_4} \times \frac{2\,mol\,Cl_2}{1\,mol\,C_2H_2Cl_4} = 0.894\,mol\,Cl_2$

② $P = 1\,atm$
$V = ?$
$T = 298\,K$
$n = 0.894\,mol$

$V = \frac{nRT}{P} = \frac{(0.894\,mol)(0.0821)(298\,K)}{1\,atm} = \boxed{21.9\,L\,Cl_2}$