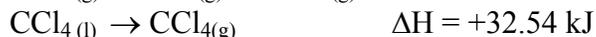# THE Review Problem

210.5 L methane gas @ 1.30atm of pressure and 298K, and 1000.2 L chlorine gas @STP are mixed together into a 2000.L container. The resulting solution of gases reacts to form a liquid and a gas. The liquid is 7.81% carbon and 92.19% chlorine with a molar mass of 153.8 g/mole and a density of 13.25 pounds per gallon. The gas that is produced has a density of 1.627 grams per liter at STP and reacts with metals to produce hydrogen gas. There is no carbon in the gas. The final temperature in the 2000.L container is 453K. Later the gas product is condensed and dissolved into 1.00×10^4 mL of water.

Thermodynamic Data

$C_{(graphite)} + 2H_{2(g)} \rightarrow CH_{4(g)}$ $\quad \Delta H = -74.9$ kJ

$C_{(graphite)} + 2Cl_{2(g)} \rightarrow CCl_{4(g)}$ $\quad \Delta H = -139$ kJ

$\frac{1}{2} H_{2(g)} + \frac{1}{2} Cl_{2(g)} \rightarrow HCl_{(g)}$ $\quad \Delta H = -92.3$ kJ

$CCl_{4 (l)} \rightarrow CCl_{4(g)}$ $\quad\quad\quad \Delta H = +32.54$ kJ

Questions:

1. Before the reaction occurs, the solution is clear and uniform. How could I separate the mixture?
2. What is the difference between a gas and a liquid on the molecular scale?
3. What is the density of the liquid in grams per milliliter?
4. What is the formula of the liquid product?
5. What is the formula for the gaseous product (it's not an element)?
6. Write a balanced equation for the reaction.
7. What is the limiting reactant?
8. How many liters of the liquid are produced?
9. How many moles of the excess reactant are leftover?
10. What is the ΔH for the reaction and is it endothermic and exothermic?
11. How much heat in kJ is released in the reaction?
12. If the heat of the reaction was added to 1×10^5 g of water @ 0.00 C, what would the final temperature be?
13. Before the gas is condensed, what was the final pressure in the container?
14. What should the concentration of the solution be when the gas product is dissolved in the water?
15. If the concentration of H^+ ions in the solution is determined to be 4.13M, then what was the percent yield?
16. If the solution from 15 was used to react with 5130g of silver nitrate, then how many grams of the solid product would be collected?
17. What are the concentrations of each of the ions that remain in this final solution?

Answers

1) Condense
2) Spacing
3) 1.596g/mL
4) CCl_4
5) HCl
6) $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$
7) Cl_2
8) 1.080 L CCl_4
9) 0.0156 mole CH_4
10) -465.8 kJ
11) -5200. kJ
12) 12.42 °C
13) 0.832 atm
14) 4.465M
15) 92.4%
16) 4328g
17) $Cl^- = 1.11M$, $H^+ = 4.13M$, $NO_3^- = 3.02M$