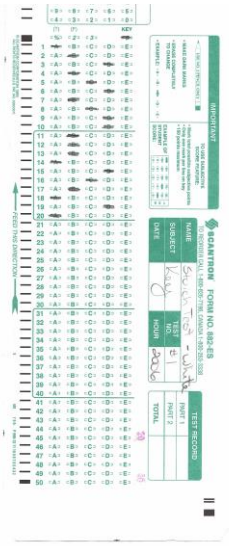

Stoichiometry Test

Part 2: Problem Solving

1. **Clearly** define **3** of the following terms: (3 marks)
   moles ratio limiting reactant theoretical yield
   percent yield actual yield

3

2. Aluminum chloride ($AlCl_3$) is formed by the reaction of aluminum with hydrochloric acid (HCl). (7 marks)
   a. Provide a balanced equation. (1 mark)

1 $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

   b. How many moles of hydrochloric acid will react with 5.0 moles of Al? (1 mark)

1 $5\text{ mol Al}\left(\frac{6\text{ mol HCl}}{2\text{ mol Al}}\right) = 15\text{ mol HCl}$

   c. How many moles of aluminum chloride will be produced if 27.0 g of Al is used? (2 marks)

2 $27.0\text{g Al}\left(\frac{1\text{ mol Al}}{27.0\text{g Al}}\right)\left(\frac{2\text{ mol AlCl}_3}{2\text{ mol Al}}\right) = 1.00\text{ mol AlCl}_3$

   d. How many grams of Al are required to produce 0.25 grams of $AlCl_3$? (3 marks)

3 $.75\text{g AlCl}_3\left(\frac{1\text{ mol AlCl}_3}{133.5\text{g}}\right)\left(\frac{2\text{ mol Al}}{2\text{ mol AlCl}_3}\right)\left(\frac{27\text{g}}{1\text{ mol}}\right) = 0.05\text{g}$

$= 0.05\text{g Al}$

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

a. How many litres of N_2 are needed to react completely with 37.9 L of H_2 if both gases are at STP? (1 mark)

$37.9\text{L } H_2\left(\frac{1\text{L } N_2}{3\text{L } H_2}\right) = 12.6\text{L } N_2$

b. How many MOLES of NH_3 will be produced if 54.75 L of H_2 gas react completely? (2 marks)

$54.75\text{L } H_2\left(\frac{2\text{L } NH_3}{3\text{L } H_2}\right)\left(\frac{1\text{ mol } NH_3}{22.4\text{L}}\right) = 1.63\text{mol } NH_3$

4. A common laboratory preparation of hydrogen on a small scale uses the reaction of zinc with hydrochloric acid that produces zinc chloride and hydrogen gas.
   a. Provide a balanced equation. (1 mark)

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

   b. How much zinc is needed to make 25.0 L of hydrogen at STP? Give your answer in MOLES and GRAMS. (3 marks)

$25\text{L } H_2\left(\frac{1\text{mol } H_2}{22.4\text{L } H_2}\right)\left(\frac{1\text{mol Zn}}{1\text{mol } H_2}\right) = 1.12\text{mol Zn}$

$1.12\text{mol Zn}\left(\frac{65.4\text{g}}{1\text{mol}}\right) = 72.99\text{g Zn}$

73.0g

1.50 mol K — 0.75 mol Cl_2 needed
0.50 mol K — 0.00 mol Cl_2 needed
∴ Cl_2 XS, K limits

5. Rock salt (KCl) can be produced according to the following reaction:
   $2K_{(s)} + Cl_{2(g)} \rightarrow 2KCl_{(s)}$
   In an experiment, a chemist placed 58.5 g of potassium and 1.00 moles of chlorine into a closed container and completed the reaction above.
   a. Before the reaction, the chemist predicted the potassium would limit the reaction. Do you agree or disagree with this prediction? Use calculations to explain your reasoning. (3 marks)

$58.5\text{g K}\left(\frac{1\text{mol K}}{39.1\text{g K}}\right) = 1.50\text{mol K}\left(\frac{1\text{mol Cl}_2}{2\text{mol K}}\right) = .75\text{mol Cl}_2$

∴ K limits ∴ agree

   b. How many moles of rock salt will be produced using the numbers above? (1 mark) 1:1 mole ratio

$1.50\text{mol K} = 1.50\text{mol KCl}\left(\frac{74.6\text{g}}{1\text{mol}}\right) = 112\text{g KCl}$

   c. How many grams of the excess chemical will remain after the reaction? (2 marks)

1 mol − .75 = .25 mol $Cl_2\left(\frac{71\text{g}}{1\text{mol}}\right) =$ 17.9 g Cl_2

   d. If 1.25 moles of rock salt are actually produced, what is the percentage yield of rock salt? (1 mark)

$\% = \frac{a}{t} \times 100 \quad \frac{1.25}{1.5} \times 100$

$= 83.5\%$