Chemistry 146 Lecture Problems
Hydrolysis of Water

In this experiment the current used for hydrolysis of water is measured and used to determine how much hydrolysis occurs. The balanced redox reaction is:

$2\ H_2O \rightarrow 2\ H_2 + O_2$

The Anode (oxidation) reaction is:

$2\ H_2O \rightarrow 4\ H^+ + O_2 + 4\ e^-$

The Cathode (reduction) reaction is:

$4\ H^+ + 4\ e^- \rightarrow 2\ H_2$

Experimental Data:

Electrolysis Current: $i := \left(28 \cdot 10^{-3}\right) \cdot amp$

Electrolysis time: $t := 0 \cdot hr + 30 \cdot min + 30 \cdot sec$ $\qquad t = 1.83 \cdot 10^{3}\ sec$

From the current and the time, calculate the total charge (in coulombs) used:

Charge Calculations

$C := i \cdot t$ $\qquad F := 96484.6 \cdot coul \cdot mole^{-1}$

$C = 51.24\ coul$

Now Calculate the number of moles used in this reaction (as it is written):

Moles of electrons:

$mole_{electron} := \frac{C}{F}$ $\qquad mole_{electron} = 5.31069 \cdot 10^{-4} \cdot mole$

Number of electrons in balanced equation: $n := 4$

Moles of reaction:

$mole_{reaction} := \frac{mole_{electron}}{n}$ $\qquad mole_{reaction} = 1.32767 \cdot 10^{-4} \cdot mole$

Moles gas from the reaction 2 H_2O -> 2 H_2 + O_2 :

Mole H_2 $\quad mole_{H2} := mole_{reaction} \cdot 2 \quad mole_{H2} = 2.65535 \cdot 10^{-4} \cdot mole$

Mole O_2 $\quad mole_{O2} := mole_{reaction} \quad mole_{O2} = 1.32767 \cdot 10^{-4} \cdot mole$

Calculated Volume of gas:

$P \cdot V = n \cdot R \cdot T \qquad T := 298 \cdot K \qquad R := 8.31441 \cdot joule \cdot mole^{-1} \cdot K^{-1}$

$V_{H2} := mole_{H2} \cdot R \cdot \frac{T}{1 \cdot atm} \qquad V_{H2} = 6.4931 \cdot mL$

$V_{O2} := mole_{O2} \cdot R \cdot \frac{T}{1 \cdot atm} \qquad V_{O2} = 3.24655 \cdot mL$

Measured Volume of gas: This is calculated from the number of centimeters of gas produced and the calibration of the volume of the glass tubing. From some previous measurements the volume of the tubing is 10 mL for every 26.4 cm of tubing.

$V_{H2\_measured} := \frac{10 \cdot mL}{26.4 \cdot cm} \cdot 18 \cdot cm \qquad V_{H2\_measured} = 6.81818 \cdot mL$

$V_{O2\_measured} := \frac{10 \cdot mL}{26.4 \cdot cm} \cdot 9 \cdot cm \qquad V_{O2\_measured} = 3.40909 \cdot mL$

The results for the two methods of calculation come out quite close to the same. With a more careful experiment (remember that the current changed some durring the time it was running) the results would be even closer.

In addition there are some other factors that we did not take into account. Do you have any thoughts about what some of these factors are?