CHM 110, Experiment 5B - How to find moles of oxygen

* You will measure the VOLUME of oxygen produced in the experiment by measuring the volume of WATER displaced by the oxygen. This causes a problem for us; some of the water vaporizes and mixes with the oxygen.

* So, the gas that displaces water is a mizture of oxygen and water vapor. We can correct for this by modifying the PRESSURE of the gas, subtracting out the pressure due to water vapor - which depends on the temperature of the gas.. This correction uses DALTON'S LAW OF PARTIAL PRESSURES (Section 5.5 in the textbook)

Example: In an apparatus similar to that used in today's experiment, you collect 675 mL of gas over water at a temperature of 27.0 C and a pressure of 29.92 in Hg. Calculate the moles of oxygen gas collected.

Use the ideal gas equation, solved for 'n':

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

$V = 675\ mL = 0.675\ L$

$R = 0.08206\ \frac{L \cdot atm}{mol \cdot K}$

$T = 27.0°C = 300.2\ K$

Units for P, V, T must match units for R

$P =$ ... needs to be corrected for water vapor

So, before we can calculate 'n', we need to correct the pressure term.

Using the chart on page 118 of the lab manual, we find that the vapor pressure (pressure over a liquid surface) of water vapor is 26.7 mm Hg at 27.0 C. The total pressure of the gas equals the pressure of the oxygen PLUS the pressure of the water vapor.

$$P_{TOT} = P_{O_2} + P_{H_2O}$$

$$P_{TOT} = 29.92 \text{ in Hg} = 760.0 \text{ mm Hg} \quad \left(\text{Factor: } \text{in Hg} = 25.4 \text{ mm Hg}\right)$$

$$760.0 \text{ mm Hg} = P_{O_2} + 26.7 \text{ mm Hg}$$

$$P_{O_2} = 733.3 \text{ mm Hg} \leftarrow \boxed{\text{Use THIS pressure to find moles of oxygen!}}$$

Now, let's solve the ideal gas equation.

$$n = \frac{PV}{RT} \qquad V = 0.675 \text{ L}$$

$$R = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$T = 300.2 \text{ K}$$

$$P = 733.3 \text{ mm Hg} = 0.9649 \text{ atm} \quad \left(\text{Factor: } \text{atm} = 760 \text{ mm Hg}\right)$$

$$n = \frac{(0.9649 \text{ atm})(0.675 \text{ L})}{\left(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}\right)(300.2 \text{ K})} = \boxed{0.0264 \text{ mol } O_2}$$