Gas Law

In this experiment you will experimentally determine the gas constant, R.

STOCKROOM

You will need to check out a digital thermometer.

CHEMICALS

You will need about 0.9 grams of zinc metal and about 25 mL of 6M HCl.

OTHER EQUIPMENT

You will need a 250 mL Erlenmeyer flask, a 500 mL Florence flask, and a 600 mL beaker. You will also need 2 pieces of rubber tubing, a one whole stopper with a piece of glass tubing inserted for your Erlenmeyer flask, a two hole rubber with glass tubing inserted for your Florence flask, and a pinch clamp.

There will also be several 500 mL graduated cylinders for the class to share.

WASTE DISPOSAL

Any 6 M HCl should go in the acid waste container. All other liquids may go down the drain. Make sure not to put any solids in the sink, they go in the trash.

SAFETY

Wear your goggles the entire time. Hydrogen gas is generated upon reaction of zinc with hydrochloric acid. Hydrogen is flammable; keep all heat and flames away from your reaction vessels.

PROCEDURE

I will demonstrate the setup of the reaction apparatus. Fill the Florence flask with tap water.

Add 25 mL of 6M HCl to the Erlenmeyer flask.

Weigh about 0.9 grams of zinc metal and record the mass to three places past the decimal in your data table.

Using a rubber bulb fill the outgoing rubber tube with water, clamping it off as close to the end as you can with the pinch clamp.

Add the zinc to the Erlenmeyer flask with the HCl in it and immediately close the stopper and release the pinch clamp.

When the reaction is complete wait 5 minutes for the temperature of the gas and water to equilibrate. Measure the temperature of the water in the 600 mL beaker. Record this in your data table.

Measure the volume of the water in your 600 mL beaker and record it in your data table.

I will write the atmospheric pressure on the board. Record this in your data table.

CALCULATIONS

Your goal is to calculate R, the gas constant, from the ideal gas law.

$$R_{experimental} = \frac{P_{H_2} V_{H_2}}{n_{H_2} T_{H_2}}$$

P_{H_2}: Because you collected the hydrogen gas over water, you must use Dalton's law of partial pressures to find the pressure of the gas:

$$P_{H_2} = P_{atm} - P_{H_2O}$$

You will look up the vapor pressure of water at the temperature of your gas in a table of water vapor pressures. P_{atm} is the atmospheric pressure I will write on the board.

V_{H_2}: The volume is the volume of gas evolved, which we assume is equal to the volume of water you collected in your 600 mL beaker. Remember to convert to liters.

T_{H_2}: This is the temperature of the gas evolved, which we assume is the same as the temperature of the water collected. Remember to convert the temperature to Kelvins.

n_{H_2}: This is the moles of gas evolved. The chemical equation that describes the chemical reaction is:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Because the mole to mole ratio between Zn and H_2 is 1:1, we will assume that the moles of gas evolved is equal to moles of zinc reacted.

You weighed the zinc, so convert that mass to moles using the molar mass of zinc (this should be in your table of constants).

Now that you've calculated R, calculate you percent error. Use 0.08206 L·atm/K·mol as the accepted value.

$$\text{Percent Error} = \frac{|0.08206 - R_{\text{experimental}}|}{0.08206} \times 100$$

CONCLUSION

Report your experimental value of R and your percent error.

Propose at least 2 sources of potential error in this experiment. Describe the effect each would have on your result (would it make your R too high or too low?) and why it would have that effect