9. Molar Volume of a Gas

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9. Molar Volume of a Gas

Purpose:

> To practice calculating the molar volume of a gas by mixing magnesium metal and hydrochloric acid to form hydrogen gas, then using the mass of magnesium used and volume of hydrogen collected to calculate the volume of one mole of hydrogen gas.

Procedure:

1. Fill a 400mL beaker two-thirds full of room temperature water.
2. Cut a piece of magnesium ribbon 1-1.5cm long. Mass the magnesium ribbon.
3. Roll the magnesium ribbon into a loose coil. Tie it with a piece of string on one end,approximately 25cm in length.
4. This step requires the use of 6M hydrochloric acid, which is caustic and corrosive. Pour approximately 10mL of 6M HCl into a 50mL eudiometer.
5. While holding the eudiometer in a slightly yipped position, slowly pour distilled water into the eudiometer, being careful not to mix the HCl and water. Completely fill the eudiometer so that there is no air.
6. Lower the magnesium coil into the water in the eudiometer to a depth of about 5cm. Insert the rubber stopper into the open end of the eudiometer to hold the thread in place. The one-hole stopper should displace some water from the eudiometer.
7. Cover the hole of the stopper with your finger and invert the eudiometer into the 400mL beaker of water.

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Clamp the eudiometer into position on the ring stand. The acid flows down the tube(less dense) and reacts with the magnesium. The acid is more dilute.

8. When the magnesium has disappeared entirely and the reaction has stopped, cover the stopper with your finger and carefully transfer the eudiometer to a 1000mL graduated cylinder or other tall vessel filled with water. Adjust the level of the eudiometer so that the height of the liquid in the 2 vessels match. Read the volume of hydrogen as accurately as possible.

9. Record the temperature of the room and atmospheric pressure.

10. Find a table of water-vapor pressures and determine the vapor pressure of the water at the temperature of the room.

Data:

Temperature: 21.5 ^{o}C

Pressure: 29.00 inHg

Water-vapor pressure: 19.25 mmHg

Mass of Mg: 0.04g

Volume of hydrogen gas: 44.85 mL

Observations:

Nothing happens when adding magnesium to water. You can see the HCl move downwards when inverting the eudiometer. Took a minute or 2 before the HCl reached the magnesium and started reacting. Started bubbling more as time went on. Started to create an air pocket at the top(bottom) of the tube. There are bubbles coming out of the stopper.

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Started slowing down as magnesium disappeared. Some HCl went out the stopper. Some bubbles stuck to the side of the tube and to the string. Magnesium eventually disappeared.

Calculations:

1. Number of moles of magnesium
   0.04/24.30 = 0.00165 moles of hydrogen reacted.
2. Partial pressure of hydrogen
   29.00*2.54/10 = 736.6 mmHg
   736.6-19.25 = 717.35
   717.35/760 = 0.944 atm of hydrogen
3. Volume at 1 atm
   $P_1V_1=P_2V_2$ 0.944*44.85=1.00*V_2 V_2=42.3mL
4. Volume at 273.15 ^oK
   $V_1/T_1=V_2/T_2$ 42.3/(21.5+273.15)=V_2/273.15
   V_2=39.2mL
5. Volume of 1 mol hydrogen at STP
   (29.2/1000)/0.00165=23.8 mol hydrogen

Conclusion:

The purpose of this lab was to calculate the molar volume of hydrogen. We achieved this by mixing a known amount of magnesium with HCl to form hydrogen gas in a eudiometer. We used he mass of the magnesium to find the moles of Mg and H_2, calculated the partial pressure of H_2, standardized it to STP, and converted that to density of H_2 at STP. It was calculated to be 23.8 mol.

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The formula for the Mg HCl reaction is $Mg+2HCl->H_2+MgCl_2$. Since the moles of Mg equal the moles of H_2 in the equation, the moles are the same. We needed to adjust for water-vapor pressure because the water will evaporate to some degree during the experiment, mixing with the hydrogen. We measured and calculated a density of 23.8 L/mol. We should have gotten a value of 22.4 L/mol, making for a 6.25% error. We measured the level of the eudiometer in a bin of water so the pressure would be equal. Some potential errors stem from the mass being so low, making the balance less accurate to the decimal place, and bad reading of the eudiometer. If I were to do the lab again, I would use a balance that can measure to more decimal places, and have a better way of calculating the value of hydrogen produced.