Lab: Collecting Gas Over Water

Background:

$$Mg(s) + 2\,HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

When magnesium reacts with hydrochloric acid, hydrogen gas is produced. This gas can be collected over water by water displacement. The temperature of the gas is taken to be the same as the temperature of the water it is in contact with. The level of the water in the container will be adjusted so that it is equal to the level of water outside the container. To do this, a leveling tank will be used. This ensures that the pressure in the container is equal to the atmospheric pressure outside the container. Because the hydrogen gas will be collected above the water, and water has a significant vapor pressure, the pressure inside the container will be a sum of the water vapor pressure and that of the hydrogen gas. The pressure of the water vapor can be found using the table below.

Table 1. Vapor Pressure of Water at Different Temperatures

Temperature, °C	P_{H_2O}, mm Hg	Temperature, °C	P_{H_2O}, mm Hg
16 °C	13.6	22 °C	19.8
17 °C	14.5	23 °C	21.1
18 °C	15.5	24 °C	22.4
19 °C	16.5	25 °C	23.8
20 °C	17.5	26 °C	25.2
21 °C	18.7	27 °C	26.7

Purpose:
To collect a gas over water and calculate its pressure and moles. To use stoichiometry to calculate theoretical yield. To calculate percent error of gas produced.

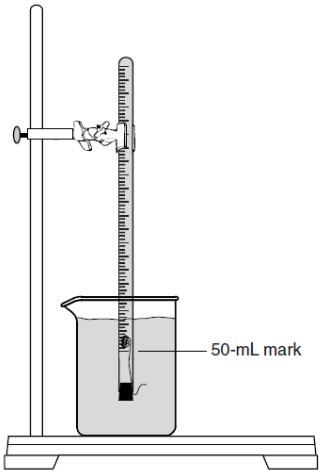
Safety:
Hydrochloric acid is a corrosive liquid. Avoid contact with eyes and skin and clean up spills immediately. Magnesium metal is a flammable solid. Keep away from flams and other sources of ignition. Wear chemical splash goggles, gloves and aprons. Wash hand thoroughly with soap and water before leaving the laboratory.

Materials:

3 M Hydrochloric Acid, 20 mL	Copper wire	Thermometer
Magnesium ribbon	50 mL graduated cylinder	Size 4 rubber stopper

Procedure:

1. Fill a plastic tub with water about 2/3 full.
2. Place 20 mL hydrochloric acid into a 50 mL graduated cylinder.
3. While holding the graduated cylinder in a tipped position, slowly and carefully fill the cylinder with water. Work slowly to avoid mixing the acid and water layers. Fill the cylinder all the way to the top so no air remains in the cylinder.
4. Set the graduated cylinder with acid and water aside to let the layers finish separating.
5. Obtain and record the mass of a strip of magnesium ribbon.
6. Obtain a piece of copper wire. Twist and fold one end of the copper wire around a pencil to make a small "cage" into which the magnesium ribbon will be inserted.
7. Firmly place the magnesium into the copper-wire cage. For larger pieces of magnesium, bend or fold the magnesium ribbon first.
8. Insert the straight end of the copper wire into a rubber stopper so that the cage end with the magnesium is below the tapered end of the stopper.
9. Insert the magnesium-copper wire-rubber stopper assembly into the graduated cylinder. The magnesium piece should be above the 50 mL mark. Do not let it mix with the acid.
10. Place your finger over the hole of the stopper, invert the cylinder and carefully lower the stoppered end into the tub of water. Make sure the rubber stopper end of the cylinder remains under the water.
11. Allow the magnesium to react. Gently tap the sides of the cylinder to dislodge any gas bubbles that may have become attached to the sides.
12. As the magnesium reacts, measure and record the temperature of the water in the tub.
13. Once the reaction is complete, cover the hole in the stopper with your finger and transfer the cylinder to the leveling tank.
14. Keep the rubber stopper end below the water. Gently move the cylinder up and down in the tank until the water level inside the cylinder is the same as the water level in the tank. This is done to equalize the pressure with the surrounding air.
15. Measure and record the volume of gas inside the cylinder.
16. Remove the cylinder from the tank and discard the water down the sink.
17. Discard the water in the tub down the sink.
18. Wash and return materials.
19. Wash your hands with soap and water.



Data Table:

Mass of magnesium	
Temperature of water	
Volume of gas in cylinder	
Atmospheric pressure	

Post-lab and Data Analysis:

1. Calculate the partial pressure of the hydrogen gas produced.

2. Calculate the moles of hydrogen gas produced.

3. Calculate the theoretical moles of hydrogen gas that should have been produced.

4. Calculate the percent error of moles of hydrogen gas produced.