INTRODUCTION:
The purpose of this laboratory experiment is to determine the universal gas constant R in the Ideal Gas Law. This can be accomplished by reacting hydrochloric acid and magnesium, trapping the hydrogen gas that is produced by the reaction, and measuring its pressure, volume and temperature. Using stoichiometry (Mole Concepts applied to chemical reactions) and the equation below, the number of moles of hydrogen gas produced from the original mass of magnesium can be determined as well. The ideal gas law and the quantities measured during the lab (P,V,T & n) will be used to calculate R. The reaction studied in this experiment is known as a single replacement reaction because the magnesium releases the hydrogen bound to the chlorine and hydrogen escapes in its elemental diatomic form. Expressed here in a reaction:

\[
\text{Mg(s) + 2HCl(aq)} \rightarrow \text{MgCl}_2(aq) + \text{H}_2(g)
\]

What will become increasingly important in this class is applying the mole ratio from a chemical reaction. Notice in this reaction that the coefficients in front of the magnesium, the magnesium chloride, and the hydrogen gas are all an understood “1”. This one-to-one relationship means, theoretically, if 2.5 moles of magnesium is used to start the reaction, then 2.5 moles of the magnesium chloride and the hydrogen gas should be produced in the presence of excess hydrochloric acid. It is a rarity for this to actually happen.

SAFETY:
SAFETY GLASSES MUST BE WORN AT ALL TIMES. Be careful when working with acids. They are corrosive. If spills occur please rinse immediately. Spilling on clothes may cause damage. Be careful with the glass and rubber stopper.

PROCEDURE:
1. Using an electric balance, record the mass of magnesium ribbon provided. ____________________ g
2. Wrap the copper wire around the magnesium ribbon, making a cage that surrounds the ribbon as demonstrated by the instructor. Leave a handle of copper wire approximately 6 cm long.
3. Insert the handle end of the copper wire into the bottom of a one-hole rubber stopper.
4. Fill the large beaker with water.
5. See the instructor to obtain approximately 10 mL of 3 M HCl.
6. Slowly with a wash bottle gently fill the eudiometer by drizzling water down the eudiometer’s inner side to avoid mixing. The HCl should stay on the bottom and the water should be filled completely up to the top.
7. Insert the stopper w/copper cage into the eudiometer by tapping gently as to avoid cracking the eudiometer. Because you The copper wire cage should be suspended at the top of the eudiometer. While holding a finger over the hole in the rubber stopper; quickly invert the eudiometer into the beaker of water. When the top of the eudiometer is under water, the finger can be removed.
8. Carefully secure the eudiometer in the buret clamp, being sure to keep the bottom underneath the surface of the water in the beaker at all times.
9. Record observations.
10. When the Mg ribbon is no longer reacting gently tap the side of the eudiometer to release any trapped bubbles.
11. Let the reaction sit for 5 minutes. Take this time to draw a diagram of your set-up.
12. Using the thermometer read and record the temperature of the beaker. ____________________ \(^\circ\)C
13. Record the atmospheric pressure as given by the instructor. ____________________
14. Determine the water vapor pressure from the table provided by the instructor. ____________________
15. Read and record the volume of gas in the eudiometer. Remember to measure how much gas was produced –a eudiometer totally full with liquid would contain 0.00mL of gas. ____________________ mL
16. Remove the eudiometer from the beaker and dispose of the contents of the beaker by pouring it down the drain.
17. Remove the stopper and note the appearance of the copper wire. Use the wash bottle to carefully rinse the eudiometer with 3-5 mL of water, twice.
18. Put everything away and clean up the work area.
Pre-Lab Questions: Answer on a separate sheet of paper.
1. What is standard temperature and pressure (STP)?
2. What is Dalton’s Law of Partial Pressure? Define it and write the two forms of the equation.
3. Why is the gas that we are collecting in this lab considered to be “wet”? How do we adjust our calculations?
4. What is the function of the copper wire?
5. What do you have to be careful of when you fill the eudiometer with water?
6. If 3.0 moles of magnesium are reacted with an excess of hydrochloric acid, how many moles of hydrogen gas would be produced if the reaction occurred at STP?
7. Is our experiment taking place at STP? Explain how this may change some of your calculations.

Post-Lab Questions and Calculations: Answer on a separate sheet of paper.
1. Use the temperature measurement and the water vapor pressure table provided in class to correct for the partial pressure of water in the gas trapped in the eudiometer—show your work! What is the partial pressure of the hydrogen gas produced?
2. Convert the mass of magnesium ribbon to moles of magnesium.
3. Using the amount of magnesium calculated in question 2, how much (in moles) hydrogen gas should have been produced under the conditions that we experienced in the classroom? Explain how you reached these conclusions.
4. Use the ideal gas law to calculate R.
5. Use your reference table to look up the true value of R and calculate your percent error. (Be careful not to calculate percent yield!)
6. Give 2 possible reasons why you had more/less gas produced than you expected.
7. **EXPLORATION:** In a different experiment, you and your lab partner react magnesium (ribbon) with hydrochloric acid. Using the balanced chemical reaction supplied in the introduction, your knowledge of Mole Concept, and the factor-label method, hypothesize a mathematical set-up for the following two situations:
   a. You and your lab partner measure out 1.25 moles of magnesium. How many moles of hydrochloric acid should be used up to react with all of the magnesium?
   b. In a second trial, 5.5 grams of magnesium are reacted with excess hydrochloric acid. How many liters of hydrogen gas will be produced theoretically? Assume STP conditions.