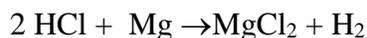Determination of the Ideal Gas Constant (R)

        In this lab we are going to experimentally measure the ideal gas constant (R of $PV = n\mathbf{R}T$). To do this we will be utilizing the reaction of magnesium with hydrochloric acid. The equation for the reaction is as follows.

$$2 \; HCl + \; Mg \rightarrow MgCl_2 + H_2$$

Equipment needed

600 mL beaker	rubber stopper with hole
10 mL graduated cylinder	Temperature probe (computer to run it)

1. Obtain a small piece of magnesium ribbon and measure its length in **centimeters** as accurately as you can (<u>to the hundredths place</u>). Record this length in the data table under trial 1.
2. **Do not push the magnesium ribbon all the way into the stopper.** Wedge part of the ribbon into the skinnier end of the rubber stopper, just enough so it won't easily fall through.
3. Fill your 600 mL beaker ¾ of the way with tap water.
4. Fill the graduated cylinder all the way up with 1 M HCl (so that it is overflowing).
5. This step must be done quickly!! Place the rubber stopper on the graduated cylinder. Place one finger over the hole in the stopper and flip the graduated cylinder upside-down into the 600 mL beaker. You will see a reaction occurring and gas forming. It is fine if the magnesium floats up into the graduated cylinder.
6. Place your temperature probe in the beaker near the mouth of the graduated cylinder.
7. Wait until the reaction completes (until the bubbling stops).
8. Convert the temperature to Kelvin and record that in your data table.
9. Tap the side of the cylinder a few times to dislodge and air bubbles that may be sticking.
10. Hold the graduated cylinder so that the water level inside the graduated cylinder and the water level of the beaker are the same (this will make the pressure inside the graduated cylinder the same as the pressure in the room). Accurately, read the volume of the gas in **milliliters** by reading the volume in the graduated cylinder (<u>to the tenths place for these graduated cylinders</u>).
11. Convert this volume to Liters and record it in your data table
12. Record the pressure in the room in kilopascals.
13. Dispose of the excess HCl in the waste container under the hood.
14. Repeat this lab two more times and record your data in the column trial 2 and trial 3 respectively.

Calculations
1. The mass of 100.0 cm of the magnesium ribbon used will be written on the board for you. Use this mass as a conversion factor convert your length of magnesium ribbon into grams of magnesium ribbon.
2. Convert your mass of magnesium to moles of magnesium ribbon, using the atomic mass of magnesium. This is the same as the number of moles of H_2 gas.
3. For each trial calculate a value for R by plugging all experimental values into the Ideal Gas Law equation. (check your units, volume must be in liters and temperature in Kelvin)
4. Take the average of all three values of R.
5. Calculate the percent error for your observed value (your average) against the accepted value of R (8.31 L kPa/mol K)

Mass of 100.0 cm of magnesium ribbon _____

	Trial 1	Trial 2	Trial 3
Length magnesium ribbon			
Mass of magnesium used			
Moles of Mg/H_2 gas (same number)			
Volume of H_2 gas			
Pressure of room			
Temperature			
Value of R			

(show work for calculation of R)

Average Value of R

Calculate the percent error for the value of R $\left|\dfrac{(\text{observed} - \text{actual})}{\text{actual}}\right|$ x 100

Answer all questions in complete sentences

1. A very round-about way was taken to determine the moles of hydrogen gas produced in this experiment. What <u>are</u> moles, and why <u>can't</u> the moles of hydrogen be measured directly?

2. To determine the moles of hydrogen, we first determined the mass of magnesium used. However, to do this we did not put the magnesium on a scale we instead measured its length, and calculated its mass by mass of 1.0 m of magnesium. Why did we not simply place the magnesium on the scale?

3. Once we had the mass of magnesium we converted the mass to moles, and said that number would be equal to the number of moles of hydrogen. How did we know the moles of magnesium was equal to the hydrogen?

4. Several students ran into difficulties because they place the stopper on the graduated cylinder and found it kept wanting to "pop off", why did it want to pop off? While they were struggling with it, instead of flipping it over, they were causing error in their lab, why?

5. To get your reading on volume you had to hold the graduated cylinder upside down and keep the water level inside the cylinder the same as the water level outside the graduated cylinder. Why did you have to do all this?