Calculating the gas constant through measuring the volume of hydrogen gas ()produced in the reaction of hydrochloric acid () and controlled amounts of magnesium ()

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Calculations

# Summary and Organization of results

Therefore, there are of hydrogen released per 1cm of magnesium.

From this, a function can derived to calculate the volume of hydrogen gas in produced by different lengths of magnesium.

Table 1. Chart of the volume of hydrogen gas produced when different length of magnesium reacts in hydrochloric acid.

| Length of Magnesium used () | Volume of hydrogen gas produced in total () | Amount of hydrogen gas produced per 1cm of magnesium ( ) |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Pressure of the gas

According to Dalton’s law, the total pressure is equal to the sum of the pressure of each element.

Where is the total pressure, is the atmospheric pressure, is the pressure on hydrogen gas and is the pressure of water vapor.

# Calculating the universal gas constant

According to the Ideal Gas Law:

Where represents the pressure, resents the volume, represent the amount of s, represents the temperature and represents the universal gas constant.

Since represents the volume of hydrogen gas produced per 1cm of Magnesium, it can be calculated from the function

The function can thus be created to calculate universal gas constant from different lengths of magnesium used.

Table 2. Chart of the universal gas constant from measured amount of hydrogen gas produced from reaction of different length of magnesium with hydrochloric acid

| Length of Magnesium used () | Universal Gas Constant calculated () | Uncertainty () |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Determining Errors

Limitations and Improvements

Table 3. Limitations and possible improvements of the experiment

| Uncontrolled variable | Impact on result | type | Improvement |
| --- | --- | --- | --- |
| Width and height of the Magnesium strip | The ratio between the lengths may not be an accurate representation of the ratio between the volume of the magnesium in the reaction. Thus, the ratios when calculating the hydrogen gas released per a unit volume may not be accurate. | Systematic | Instead of measuring length of Magnesium strip, the mass should be measured instead. This way, it makes sure that the amount of magnesium have a valid ratio to determine results of the reaction. |
| Gas leaking into the 10 graduated cylinder when transferring the cylinder around. | Gas often leaks into the cylinder when transferring the graduated cylinder between places, since at some instances the only barrier at some instances is one’s hand. This would directly affect the amount of hydrogen measured, and thus the results | Systematic | Use a cap that is able to seal the cylinder completely so that there would be no worries of gasses leaking into the graduated cylinder. |
| Room temperature and pressure is not at STP | The molar volume if Ideal gas is a required constant for this experiment as it is involved directly in the calculations. However, molar volume of Ideal gas is only known for it at STP condition, which is not the condition which the experiment is performed under. This will cause uncertainties in the calculation, as the actual molar volume of hydrogen will be different. | Systematic | Preform the experiment in an environment which is at STP or have the hydrogen’s molar mas as a known constant for the experimenting environment. |
| The amount of hydrogen while measuring | The amount of hydrogen in the graduated cylinder is measured by reading the values on the side of the cylinder when the transparent liquid in and outside of the cylinder line up. With the similar color, observers may measure different value of hydrogen gas from the actual amount. | Random | Dye a liquid with food coloring so that the two liquids are more distinguishable for observers, which may allow more accurate measuring of the amount of hydrogen.  More trials should also be preformed to minimize the effect of this random error. |
| The time taken for the reaction to finish | The end of the reaction was judged by eye, and some samples may be measured without the reaction fully complete. This would directly change the amount of hydrogen in the cylinder and thus impact the results | Systematic | Before the experiment, determine an time which a certain amount of magnesium takes to react with hydrochloric acid, and use that time as reference to wait during the experiment. |