

# Valency of magnesium | experiment



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Stoichiometry is a branch of chemistry that deals with relative quantities of reactants and products in a chemical equation. In a balanced chemical equation, we can find the relation (quantities) between products and reactants typically form the ratio of positive integers. Hence, we can use this ratio to determine the quantities such as amount of products produced or amount of reactant used in the term of volume, mass or moles. This developed relation play the important roles in determining the percentage yield as we are using this relation to calculate the theoretical yield of the reactant for a complete reaction. Stoichiometry calculation also can use to predict how elements and components dilute in a standard solution react in experimental conditions. Stoichiometry is founded by the law of conservation of mass which stated the mass of reactant equals to the mass of products.

Valency is the number of unpaired electrons in an atom's outermost shell. The maximum valency of an atom is 8. Up to a valency of 3, the atoms shed the electrons and become charged ion except helium. These ions will accept the electrons as an equal and opposite charge from anion thus form ionic bonding between them. At a valency of 4, the atoms will form a covalent bond which is weaker than ionic bond. From a valency of 5 to 7, the atoms will either accept the electrons from others and become charged or share electron among their same species by covalently bonded together. For the valency of 8, these type of elements are the inert species at which they will not share or donate electron with others species because they had already achieve the stable octet electron configuration. This inert species also include the helium atom although it is not having the valency of 8. Helium

having 2 electrons on the outermost electron shell which form the stable duplet electron configuration.

Magnesium having the atomic number of 12 (electron configuration:  $1s^2 2s^2 2p^6 3s^2$ ). It has 2 electrons at the outermost electron shield, so its common oxidation state is +2. Furthermore, it has 3 stable isotopes which is  $^{24}\text{Mg}$ ,  $^{25}\text{Mg}$  and  $^{26}\text{Mg}$ . Magnesium is soluble in water and form strongly basic solution when reacts with water. It will form the ionic bonding with the non-metal elements (except group 18) by donating their extra electron to achieve stable electron arrangement or they will form metallic bonding with metal elements by delocalized their valence electron.

## **Apparatus & Material**

- Apparatus/Glassware: Burette Pipette Watch Glass Gauze Funnel Glass Rod Retort Stand Analytical Balance Beaker
- Material/Chemical: Magnesium Ribbon Hydrochloric acid (HCl), 0.5M

## **Methodology**

Procedure:

25.00 cm<sup>3</sup> of water was pipetted and transferred into the burette.

The reading of the burette was noted and the volume of unmarked space of the burette was determined.

A piece of Magnesium ribbon was cleaned by the sand paper.

The magnesium ribbon was cut off with scissors and weighed accurately between 0.0300g and 0.0360g by analytical balance.

A small filter funnel with short stem (1.0cm-1.5cm) was covered with gauze.

A watch glass was placed inside the beaker and the magnesium ribbon was coiled thus putted on the watch glass.

The small filter funnel was inverted and placed on the watch glass over the magnesium.

The beaker was carefully filled with tap water until the level is approximately 0.5cm-1.0cm above end of the funnel stem.

0.5M of hydrochloric acid was added overflow to the burette and inverted place in the water in the beaker.

The end of the burette was moved over the stem of the funnel and the burette was clamped into position.

The excess water in the beaker was drained out until it's left approximately 0.5cm-1.0cm above end of the funnel stem.

About 100cm<sup>3</sup> of 0.5M HCl was added to the beaker and mixed gently with water by glass rod.

The solution was stirred to initiate the reaction and glass rod was used to tap the filter funnel in order to ensure the HCl flowed inside the funnel.

The reaction was completed around 30 minutes usage of time, glass rod was used to tap the watch glass to dislodge any gas bubbles.

The volume of gases evolved was determined.

## Result

Mass of magnesium ribbon used:  $(0.0320 \pm 0.001)$  g

### Determination of unmarked part's volume

Volume of water added into burette

25.00 cm<sup>3</sup>

Burette reading

29.10 cm<sup>3</sup>

∧∧ Volume of unmarked space

4.10 cm<sup>3</sup>

### Determination of volume of gases evolved throughout the reaction

Final burette reading after reaction

26.50 cm<sup>3</sup>

Volume of unmarked space

4.10 cm<sup>3</sup>

Total volume of gases evolved

30.60 cm<sup>3</sup>

## Question and Answer

1. It is advisable that the temperature is not taken for at least 20 minute after adding the hydrochloric acid. Why is this so?

Answer: The temperature is taken after 20 minutes after adding HCl because heat will be produced during the formation of Magnesium chloride. The ideal gas law equation ( $PV = nRT$ ) had clearly show that the number of moles is inversely proportional to the temperature. So we need to wait the temperature stabilize first before we measure, because it will affect our number of moles of hydrogen gas that evolved.

2. Calculate the moles of hydrogen gas present using the given calculation method.

Answer:  $PV = nRT$   $n = PV/RT$   $n = (1.013 \times 10^5 \text{ Pa}) (30.60 \times 10^{-6} \text{ m}^3) / (8.3142 \text{ J/K. mol}) (25 + 273.15 \text{ K}) = 1.2505 \times 10^{-3}$

3. Give the Ideal Gas equation and specify what each variable is. Show one mole of gas at s. tp. occupies 22.4L.

Answer:

Boyle's Law stated that the volume of gases is inversely proportional to the pressure. Equation  $V \propto 1/P$

Charles's Law stated that the volume of gases is directly proportional to temperature. Equation  $V \propto T$

Avogadro's Law stated that the volume of gases is directly proportional to number of moles. Equation  $V \propto n$

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By combining this three ideal gas law, we can get the equation of

$$PV = nRT$$

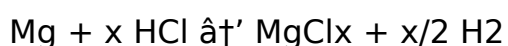
We know that the standard pressure is 1 a. t. m which is equal to  $1.013 \times 10^5$  Pa, and the absolute temperature is 273. 15K.

$$V = (1 \text{ mol}) (8.3142 \text{ J/K. mol}) (273.15\text{K}) / (1.013 \times 10^5) = 0.0224 \text{ m}^3 = 22.4 \text{ L (shown)}$$

4. What will be the result if hydrogen gas, H<sub>2</sub>, leaks through the stopcock of the inverted burette?

Answer: If the hydrogen gas leaks out, the volume of hydrogen gas collected will be lesser than the actual volume of the hydrogen gas evolved. Hence, our calculation of number of moles of hydrogen gas will be affected because volume is directly proportional to number of moles.

5. Given the equation:



Based on the experimental result, determine 'x' and valency of Mg.

$$\text{Number of moles of Mg} = 0.0320 \text{ g} / 24.31 \text{ g/mol} = 1.3163 \times 10^{-3} \text{ moles}$$

From the equation shown, we know that 1 moles of Mg produce x/2 moles of H<sub>2</sub>.

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number of moles of Mg = 1 number of moles of H<sub>2</sub> x/2

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$x = 2$  (number of moles of  $H_2$ ) (number of moles of  $Mg$ ) =  $2 (1.2505 \times 10^{-3} \text{ moles}) / (1.3163 \times 10^{-3} \text{ moles}) = 1.900 \hat{\%}^2$

The oxidation state of  $MgCl_2$  is 0

$\hat{\%}^2 MgCl_2 = 0 Mg + 2Cl = 0 Mg + 2(-1) = 0 Mg = +2$

Thus, the valency of magnesium is 2.

## Discussion

In this experiment, we are confirming the valency of magnesium by using a known starting mass of magnesium and the measured collection of hydrogen gas. By using the stoichiometry method, we can know the relation between the product and reactant in term of number of moles from the balanced equation. Thus, we can determine the 'x' value and valency of magnesium by obeying the law of conservation of mass.

The reaction between magnesium and hydrochloric acid is acid-base reaction which will form the salt at the end of the reaction, in this case the salt would be the magnesium(II) chloride. From the data collected, we know that the magnesium's valency is 2 which mean 1 magnesium atom will react with 2 chlorine atom to form magnesium chloride. They are bonded by the ionic bond which magnesium donates 2 electrons to chlorine in order for both of the atoms achieve the stable electron arrangement. This compound is polar compound because the great differences between the electronegativity of magnesium and chlorine.

Besides that, this reaction also is an exothermic reaction because it releases heat during the reaction. Exothermic reaction is a chemical reaction that

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release energy in the form of light or heat throughout the reaction, thus the final energy level is always lower than the initial energy level. In this experiment, the temperature is the important factor that will directly influence to the data which is the number of moles of hydrogen collected. As the references of the ideal gas law,  $PV = nRT$ , when the temperature increases the volume of gases also will be increased as well because the gases will expand under high temperature. Besides, the fluctuation of the pressure also will affect the result, so the experiment should be conducted in non-windy condition in order to have a stable pressure for the experiment.

Few precaution steps should be taken in order to get a better and accurate result; firstly, we must ensure the burette is not leak because it will affect our experimental result. Secondly, the burette should be filled fully before invert and put on the end of the funnel. Following by, the gauge used to cover the end of the funnel (to prevent the magnesium flow out from the funnel) should not be too used because it will trap the hydrogen gas inside the funnel and it will not release to the burette. Besides that, we should place our eye perpendicularly to the scale on the burette when we taking the reading and take several times of the reading (take average) to reduce the error present in the experiment. Lastly, ensure the magnesium do not escape from the funnel, if not the hydrogen gas evolved will not collected to the burette and cause the experimental result inaccurate.

## **Conclusion**

According to the law of conservation of matter, the mass of reactants is always equal to the mass of products. The 'x' value in the equation is 2 and the valency of magnesium also is 2 as well. Thus, 2 moles of HCl (at least) is

needed to react completely with 0.0320g of magnesium in order to produce 30.60 cm<sup>3</sup> of hydrogen gases.