

Experiment Time: 2019 / 04 / 27 08 : 30 ~ 12 : 10

Laboratory: DS2B4

Experimental Report

Experiment Course Title: Experimental of College Chemistry I

Experimental Project Name:

A: Oxidation Reduction and Electrochemistry

B: Metal corrosion and protection

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College: JCI Specialty: Mechanical Engineering

Class: ME01 Mentor: Chen Gang

Score: _____

Teacher Comments: _____

1. Purpose

Experiment A

- (1) Learn method for determining the gas constant and its operation
- (2) Grasp the ideal gas equation of state and law of partial pressure applications
- (3) Learning use amount trachea and barometer.

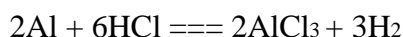
Experiment B

- (1) Learn chemical reaction enthalpy measurement method principle, and learn enthalpy change determination;
- (2) Master the correct use of a precision thermometer.

2. Principle and Method

Experiment A

Ideal gas law is: $pV = nRT$, gas constant in the equation is: $R = pV/nT$. For a certain amount of gas, its volume can be measured at a given temperature and pressure then the R value can be derived. The chemical reaction equation for the experiment as follows:



Because hydrogen is collected from the surface of water, therefore in hydrogen mixed with steam. Find out water vapor pressure at experimental temperature, and the hydrogen partial pressure can be determined according to the laws of partial pressure. The equation as follows:

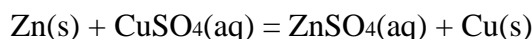
$$p = p(H_2) + p(H_2O)$$

$$p(H_2) = p - p(H_2O)$$

The calculated data into the formula can get R :

Experiment B

Chemical enthalpy change in the standard state is called the standard chemical enthalpy change, represented by $\Delta_r H^\circ$, the subscript r represents the general chemical reaction, and the superscript $^\circ$ represents the standard state. In practical work, many important data is measured at 298.15K, usually the chemical reaction enthalpy change under 298.15K, denoted by $\Delta_r H_m(298.15K)$. Determination replacement chemical reaction enthalpy of solids zinc with copper sulfate solution of copper ion is followed:



$$\Delta_r H_m(298.15K) = -217 kJ \cdot mol^{-1}$$

This equation indicates: In the standard state, 298.15K, the reaction occurred in a unit, namely replacement reaction of 1mol Zn and 1mol CuSO₄ occurred, then generate 1mol ZnSO₄ and 1mol Cu. The chemical reaction enthalpy $\Delta_r H_m(298.15K)$ is called standard molar enthalpy in 298.15K, and the unit is $kJ \cdot mol^{-1}$.

Instrument of determine chemical reactions thermal effects is calorimeter. In the experiment It can

determine the chemical reaction of molar enthalpy, if you ignore the calorimeter heat capacity. The formula following:

$$rH_m[(273.15+t)K] = - \frac{T \cdot c \cdot v \cdot 1}{1000}$$

rH_m 1/2 the molar enthalpy of chemical reaction in experiment temperature (273.15+t)K, (kJ·mol⁻¹)

T 1/2 changes the temperature of solution after the reaction(K)

c 1/2 specific heat capacity of CuSO₄ solution(J·K⁻¹·g⁻¹)

ρ 1/2 density of CuSO₄ solution(g·cm⁻³)

v 1/2 Volume of CuSO₄ solution(cm³)

$$\xi \text{ 1/2 the reaction progress variable(mol)} = \frac{n(\text{CuSO}_4)}{\nu(\text{CuSO}_4)}$$

n(CuSO₄) is the change of amount of substance of CuSO₄ solution after the reaction

ν(CuSO₄) is the measured in number of chemical of CuSO₄ solution.

3. Materials and Instruments

Experiment A

1 Materials

HCl (2 mol/dm³), Aluminum foil (s)

2 Instruments:

Determination of gas constant equipment, graduate (10 cm³), thermometer, barometer.

Experiment B

1 Materials

CuSO₄ solution 0.2000 mol/dm³

Zn AR

The preparation and calibration of 0.2000 mol/dm³ CuSO₄ solution as followed:

Take a little more than the required amount of analytical grade CuSO₄·5H₂O crystals in a clean mortar in the study after the fine, into the weighing pan or pan, and then placed in the thermostat drying oven, bake 1 ~ 2h at less than 60 °C, remove, cool to room temperature, put into the dryer in reserve.

On the analytical balance, we accurately weighed 49.936g CuSO₄·5H₂O crystals in a 250cm³ beaker, added about 150 cm³ of deionized water, stirred with a glass rod to dissolve it completely, and poured the solution into the 1000 cm³ volumetric flask, with deionized water glass bead and beaker rinse 2-3 times, the washing liquid into the volumetric flask completely, and finally diluted with deionized water to the mark, shake well.

Take the CuSO₄ solution 25.00 cm³ in 250 cm³ conical flask, adjust the pH to 5.0, add 10 cm³ NH₃·H₂O-NH₄Cl buffer solution, 8-10 drops of PAR indicator, and 4-5 drops of methylene blue, shake well, titrated with EDTA standard solution immediately until the solution from the purple-red to yellow green.

2 Instruments:

balance, calorimeter, precision thermometers, pipettes, ear cleaning ball, pipette holder, magnetic stirrer, weigh paper

4. Experimental Records and Calculation

Experiment A

After measurement, we get $m = 0.0352\text{g}$, $V_{\text{before}} = 5.5\text{cm}^3$, $V_{\text{after}} = 55.3\text{cm}^3$, $t = 26.50$ $P = 96.61\text{KPa}$

By calculating we get $P(\text{H}_2\text{O}) = 3.3639\text{KPa}$, $V(\text{H}_2) = 4.98 \times 10^{-5}\text{m}^3$, $P(\text{H}_2) = 93.25\text{KPa}$, $n(\text{H}_2) = 0.00222\text{mol}$

According to the equation $R = \frac{(p_2 - p_1) V}{n T}$, we get $R = 6.98\text{J mol}^{-1}\text{K}^{-1}$

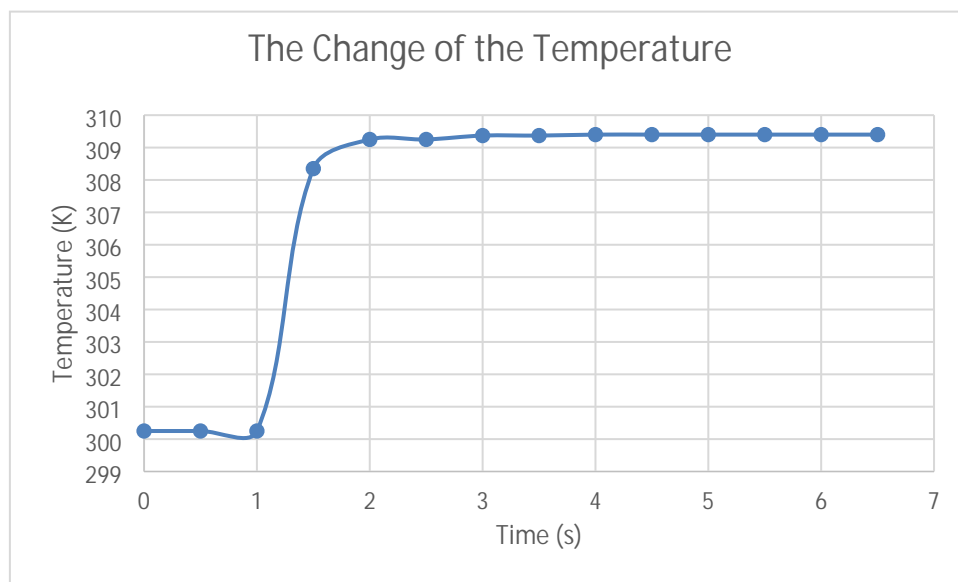
According to the equation, $\text{error} = \frac{|R_{\text{General}} - R|}{R} \times 100\% = 17.1\%$

Experiment B

$T = 26.50$ $c(\text{CuSO}_4) = 0.2047\text{mol/dm}^3$ $(\text{CuSO}_4) = 1.048\text{g/dm}^3$ $C = 4.18\text{J g}^{-1}\text{K}^{-1}$

The Change of the Temperature														
t(min)	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5
t(°C)	27.1	27.1	27.1	35.2	36.1	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2
T(K)	300.25	300.25	300.25	308.35	309.25	309.25	309.37	309.37	309.4	309.4	309.4	309.4	309.4	309.4

Form 1



(Graph 1)

$$= \frac{(4)}{(4)} = 0.0409$$

$$\Delta H_m [(273.15+t)\text{K}] = -T \cdot c \cdot v \cdot 1/1000 = -196.00\text{kJ/mol}$$

$$\text{Error} = \frac{|r_{Hm} - r_{Hm}|}{r_{Hm}} \times 100\% = 9.68\%$$

5. Results and Discussion

Results:

Experiment A

The gas constant of this experiment is $6.98 \text{ J mol}^{-1} \text{ K}^{-1}$.

The actual value is actual value is $8.314471(14) \text{ J mol}^{-1} \text{ K}^{-1}$.

According to the equation, $\text{error} = \frac{|\text{R} - \text{R}_{\text{actual}}|}{\text{R}_{\text{actual}}} \times 100\%$, we get error = 17.1%

Experiment B

Results of determination of enthalpy change in chemical reaction 146.56 kJ/mol

The chemical reaction molar enthalpy change is 196.00 kJ/mol

Error is $\frac{|196 - (217)|}{217} \times 100\% = 9.68\%$

Error analysis:

Experiment A

The error of experiment A is 17.1%. The error is small that proves our experiment result is accurate.

The elements which are caused the error may be the instrumental error and reading error.

Experiment B

The error of experiment B is 9.68%.

A) The heat insulation property of cup is not very good. That causes the heat loss then the temperature will reduce.

B) When add the zinc into the cup, the action is not quick enough. That may cause the heat loss.

C) There are instrumental error and reading error.

Discussion:

Experiment A

When reading the volume of the gas, why should the liquid level position of the measuring pipe and the horizontal pipe be kept at the same level?

In order to ensure that the pressure of water on the air is zero, if the liquid level in the pipe is higher than that outside, there will be negative pressure on the gas, the reading result will be larger, and if the liquid level is lower than that outside, there will be positive pressure on the gas, resulting in a smaller result.

Experiment B

When calculating the enthalpy change of chemical reaction, why not use the difference between the equilibrium temperature before reaction and the maximum temperature after reaction, but use the T value obtained by extrapolation of t-T curve?

Extrapolation can eliminate the effect of heat dissipation on the experiment. If the maximum temperature is used to make a difference, the result will be smaller. This systematic error should be avoided in the experiment.