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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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:

$$2Al + 6HCl === 2AlCl_3 + 3H_2 \uparrow$$
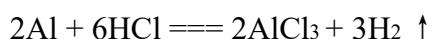
Because hydrogen is collected from the surface of water, therefore in hydrogen mixed with steam. Find out water vapor pressure at experimental temperature, and the hydrogen partial pressure can be determined according to the laws of partial pressure. The equation as follows:

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

The calculated data into the formula can get R:

$$R = \frac{p(H_2)\, V(H_2)}{n(H_2)\, T}$$

Experiment B

Chemical enthalpy change in the standard state is called the standard chemical enthalpy change, represented by $\Delta_r H\theta$, the subscript r represents the general chemical reaction, and the superscript θ 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 $\Delta_r H\theta$ (298.15K). Determination replacement chemical reaction enthalpy of solids zinc with copper sulfate solution of copper ion is followed:
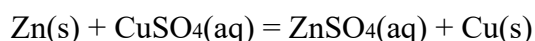
$$Zn(s) + CuSO_4(aq) = ZnSO_4(aq) + Cu(s)$$
$$\Delta_r H\theta_m(298.15K) = -217 kJ \cdot mol_{-1}$$

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 $\Delta_r Hm$ (298.15K) is called standard molar enthalpy in 298.15K, and the unit is kJ • 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:

$\Delta_r H_m[(273.15+t)K] = -\Delta T \cdot c \cdot \rho \cdot v \cdot 1/\Delta\xi \cdot 1/1000$

$\Delta_r H_m$ — the molar enthalpy of chemical reaction in experiment temperature $(273.15+t)K$, $(kJ \cdot mol^{-1})$；

ΔT — changes the temperature of solution after the reaction(K)；

c — specific heat capacity of $CuSO_4$ solution$(J \cdot g^{-1} \cdot K^{-1})$；

ρ — density of $CuSO_4$ solution$(g \cdot dm^{-3})$；

v — Volume of $CuSO4$ solution(cm^{-3})；

$\Delta\xi$ — the reaction progress variable(mol) ， $\Delta\xi = \Delta n(CuSO_4)/ \upsilon(CuSO_4)$ ，

$\Delta n(CuSO_4)$ is the change of amount of substance of $CuSO_4$ solution after the reaction，

$\upsilon(CuSO_4)$ is the measured in number of chemical of $CuSO_4$ 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

　　$CuSO_4$ solution： 0.2000 mol·dm₋₃

　　Zn（AR）

　　The preparation and calibration of 0.2000mol•dm₋₃ $CuSO_4$ solution as followed:

　　①Take a little more than the required amount of analytical grade $CuSO_4$•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℃, remove, cool to room temperature, put into the dryer in reserve.

　　②On the analytical balance, we accurately weighed 49.936g $CuSO_4$•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.

　　③Take the $CuSO_4$ solution 25.00 cm₃ in 250 cm₃ conical flask, adjust the pH to 5.0, add 10 cm₃NH₃•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_{Al}=0.0352g, $V_{1before}$=5.5cm³, V_{2after} = 55.3cm³, t=26.50℃, P=96.61KPa

By calculating we get P(H₂O)=3.3639KPa, V(H₂)=4.98×10⁻⁵m³, P(H₂)=93.25KPa, n(H₂)=0.00222mol

According to the equation $R = \frac{p(H_2)V(H_2)}{n(H_2)T}$, we get R = 6.98J×mol⁻¹×k⁻¹

According to the equation, error = $\frac{|R_{Gengral} - R_{Truth}|}{R_{General}}$ ×100% = 17.1%

Experiment B

T=26.50   c(CuSO₄)=0.2047mol/dm³   ρ (CuSO₄)=1.048g/dm³ C=4.18J×g⁻¹×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(℃)	27.1	27.1	27.1	35.2	36.1	36.2	36.2 2	36.2 2	36.2 5	36.2 5	36.2 5	36.2 5	36.2 5	36.2 5
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）

The Change of the Temperature
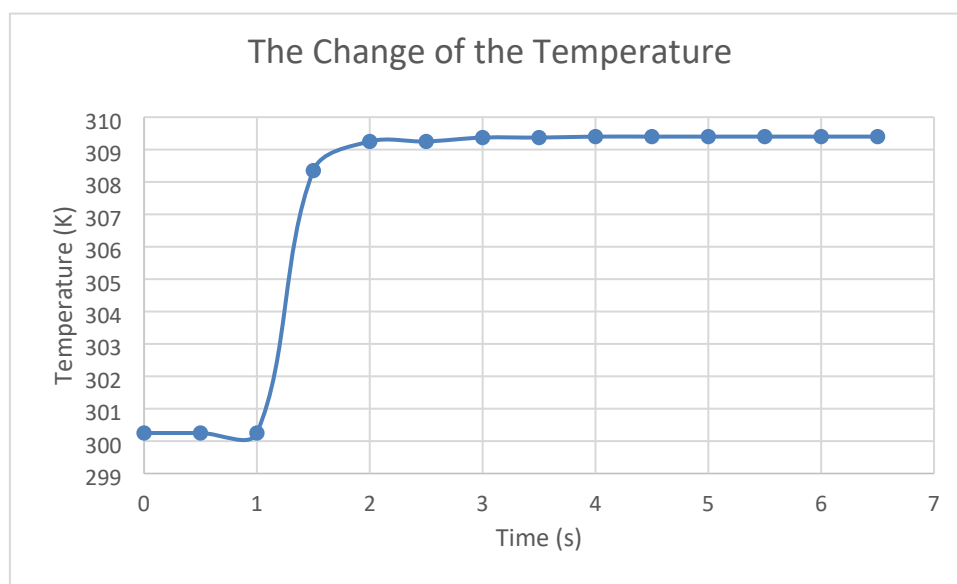
(Graph 1)

$$\Delta\xi = \frac{\Delta n(CuSO_4)}{v(CuSO_4)} = -0.0409mol$$

$\Delta_r H_m$ [(273.15+t)K] = -ΔT·c·ρ·v·1/Δξ ·1/1000 = -196.00kJ/mol

Error = $\frac{|\Delta_r H_{m General} - \Delta_r H_{m Truth}|}{\Delta_r H_{m General}}$ ×100% = 9.68%

5. Results and Discussion

Results:
Experiment A
The gas constant of this experiment is 6.98J×mol^{-1}×k^{-1} .
The actual value is actual value is 8.314471(14) J×mol^{-1}×k^{-1} .
According to the equation, error = abs(R 通用-R 真实)/R 通用×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.