Experiment Time: 2019 / 05 / 07 14 : 00 ~ 16 : 30 Laboratory: DS2B409

Experimental Report

Experiment Course Title: Experimental of College Chemistry I

Experimental Project Name:

Determination of ionization constant of acetic acid

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Score:_____

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1. Purpose

(1) Practice the basic operation method of calibrating the concentration of solution

(2) Have a deeper understand of the concept of weak electrolyte ionization equilibrium

(3) To understand the principle and method of measuring the degree of ionization and ionization constant

(4) Learn the proper use of pH meter, burette and pipette

2. Principle and Method

(1) Concentration of acetic acid solution:

The amount of substance n(A) consumed in the reaction is equal to the amount of substance n(B) used in the reaction.

$$aA + bB == gG + dD \text{ That is: } n(A) == n(B)$$

In this experiment, the reaction function is:

$$HAc(aq) + NaOH(aq) == NaAc(aq) + H_2O(l)$$

At the end of titration:

$$n(HAc) == n(NaOH) \text{ That is: } c(HAc)V(HAc) == c(NaOH)V(NaOH)$$

Then, the concentration of HAc solution is:

$$c(HAc) == c(NaOH)V(NaOH)/ V(HAc)$$

(2) Determination of ionization constant of acetic acid by pH:

Acetic acid (CH3COOH, abbreviated as HAc) is weak electrolyte, there are dissociation equilibrium in aqueous solution:

$$HAc \leftrightarrows H^+ + Ac^-$$

Expression of ionization equilibrium constant:

$$K(HAc) = c(H^+)*c(Ac^-)/c(HAc) = c\alpha* c\alpha/(c-c\alpha);$$

So

$$K(HAc) = c\alpha^2/(1 - \alpha)$$

At a certain temperature, the pH values of a series of acetic acid solutions with different concentrations were measured by pH meter. Conversion of $c(H^+)$ in different concentrations of acetic acid solution. According to the formula: $c(H^+) = c\alpha$; $\alpha = \{ c(H^+)/c\} * 100\%$, we can obtain the ionization degree of acetic acid solution with different concentration α. Finally according to $K(HAc) = c\alpha2/(1 -\alpha)$, we can obtain a series of corresponding ionization constants K(HAc). The average value is the ionization constant of acetic acid in such certain temperature.

3. Materials and Instruments

(1) Instruments:

One acid burette ($50cm^3$); One base burette ($50\ cm^3$); Two Conical flask ($250cm^3$); One wash bottle; One pipette ($20cm^3$); Four small beaker ($50cm^3$); One Titration stand and one burette clamp; One pipette holder; One aurilave; One pH meter; One thermometer (0 ~ 100℃)

(2) Materials:

HAc ($0.1mol*dm^{-3}$), NaoH ($0.1000mol*dm^{-3}$), phenolphthalein indicator (1%)

4. Experimental Records and Calculation

(1) Concentration of acetic acid solution:

c(HAc)actual=0.1 mol*dm^{-3}

1#	2#
V_2=20.80cm^3	V_2=24.59cm^3
V_1=1.50cm^3	V_1=5.71cm^3
V(HAc)=19.30cm^3	V(HAc)=18.88cm^3
V(NaOH)= 20.00cm^3	
c(NaOH)= 0.09838mol*dm^{-3}	
c(HAc)= c(NaOH)* V(NaOH)/ V(HAc) =0.1019mol*dm^{-3}	c(HAc)= c(NaOH)* V(NaOH)/ V(HAc) =0.1042mol*dm^{-3}
c(HAc)ave=0.1031 mol*dm^{-3}	

We calculate the average value:

c(HAc)actual=0.1 mol*dm^{-3}

Error%=(c(HAc)ave- c(HAc)actual)/ c(HAc)actual= 3.1%

(2) Determination of ionization constant of acetic acid by pH:

c(HAc)origin=0.1031mol*dm^{-3} t=19.1℃

	V(HAc) cm^3	V(H_2O) cm^3	c(HAc) mol*dm^{-3}	pH	c(H+) mol*dm^{-3}	α%	K(HAc)
1#	32.00	0.00	0.1	2.93	0.00120	0.0120	1.46×10^{-5}
2#	16.00	16.00	0.05	3.11	0.00076	0.0152	1.17×10^{-5}
3#	8.00	24.00	0.025	3.26	0.00055	0.0220	1.24×10^{-5}
4#	4.00	28.00	0.0125	3.67	0.00021	0.0168	3.59×10^{-5}
k(HAc)ave	1.29×10^{-5}						

Because the result of 4# have a distinctive error, we delete it and calculate the average value of k(HAc):

k(HAc)actual=1.75×10^{-5}

Error%=(k(HAc)ave- k(HAc)actual)/ k(HAc)actual = 26.29%

5. Results and Discussion

Results:

(1) Concentration of acetic acid solution:

$c(HAc)ave=0.1031\ mol*dm^{-3}$

$c(HAc)actual=0.1\ mol*dm^{-3}$

Error%=(c(HAc)ave- c(HAc)actual)/ c(HAc)actual= 3.1%

(2) Determination of ionization constant of acetic acid by pH:

$k(HAc)ave=1.29\times10^{-5}$

$k(HAc)actual=1.75\times10^{-5}$

Error%=(k(HAc)ave- k(HAc)actual)/ k(HAc)actual = 26.29%

Error analysis:

A. Temperature error

During the experiment, the temperature was changing. Due to the air conditioner, the temperature was changing from 18.7℃ to 19.5℃. We took the average value as the temperature value, but there was still some error effecting the result.

B. Reading error

There may be random error caused by reading the result.

C. pH meter error

This is the system error. When we tested the PH of the solution, we should use filter paper clean the probe of the pH meter, but there was still some solution remained on the probe. The remained solution may effect the result of the experiment.

Discussion:

(1) Concentration of acetic acid solution:

The result we get is very close to the actual value. The error is just 3.1%.During the experiment we paid attention to details so that the experiment is successful.

A. Transfer the solution

When we transported the solution with pipette, we transferred accurate liquid into the flask. Sight and scale line are on the same level.

B. Titrate solution

Before titrating solution, we rinsed burette for several times and exhausted bubbles in the mouth of the burette. During titrating the solution, we let solution outflow slowly. When solution dropped into the conical bottle, we also shook it so that the reaction will be more fully. When reading the result, sight and scale line were on the same level.

(2) Determination of ionization constant of acetic acid by pH:

By measurement and calculating, the ionization constant of acetic acid is 1.29×10^{-5}.Comparing with the actual value 1.75×10^{-5} in 22℃， the error percentage is 26.29%. We should analyses the causes of error.