全国高等医学院校配套实验教材

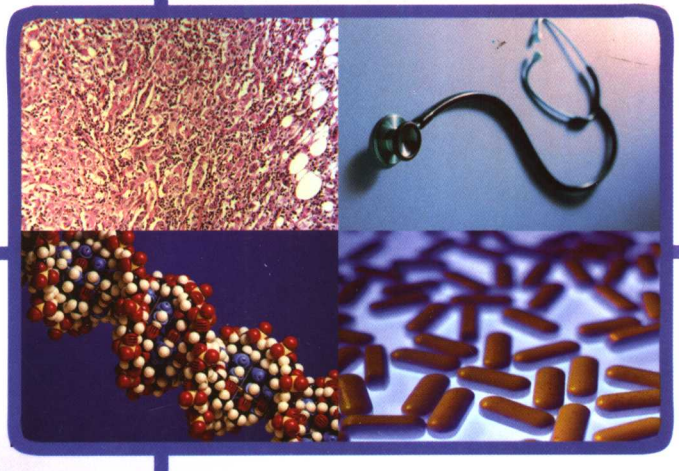
BASIC MEDICAL CHEMISTRY EXPERIMENT

医用基础化学实验

（英文版）

Editors Sun Lian Chang Junmin

主 编 孙 莲 常军民



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内 容 简 介

本书为英文版医用基础化学实验教材，是医学院校本科生医用化学方法的基础教学，为培养学生的科学思维方法而编写的。全书内容包括：实验的一般规则、实验报告的格式及21个基础化学实验。特点是：英文教学，适用性强，具有科学性、创新性。

本书可适用于全国高等医学院校本科生用。

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PREFACE

Experiment teaching is one of the most fundamental teaching to clinical medicine specialized students, playing an important role in training scientific thoughts and methods, creative consciousness and ability of the students as well as in promoting quality-oriented education in all-round way.

Based on the experience of medical basic chemistry experiment teaching for many years, by using for reference the experiments of inorganic chemistry and analytical chemistry in other colleges and universities, we have finished this textbook. The experiments in this textbook have the individuality, systematicness and scientificalness and emphasis the connecting with other experimental courses, which helps the foreign students to grasp basic techniques of operation within the class hours of experimental teaching prescribed by teaching syllabus and to improve their experimental ability and finally to cultivate a scientific approach of precision, practicality and creation.

21 experiments have been compiled, including 15 validate experiments, 5 comprehensive experiments and 1 designing experiment in this textbook. Validate experiments is on the training of basic experiments to intensify students' basic experiment skills and comprehensive experiment can train students' abilities in analyzing and solving complicated problem, designing experiment can improve students sense and ability of blazing new trails. Besides, after each experiment, we have compiled the preview; operation instructions, and points for attention, questions.

During compiling this textbook, we have tried our best to select suitable materials, however, there are still something improper or even erroneous due to our academic limitations. We would be most appreciative if anyone could give us good suggestions on improving this experimental textbook.

Editor

July 7 2006

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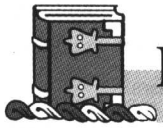


EXPERIMENTAL GENERAL RULE

Laboratory rule

(1) To prepare a lesson earnestly before the experiment. To indicate clearly about the goal and request of the experiment. To clarify the related basic principle, sequence of the operation, and about safety in the experiment.

(2) To put on the working clothes before entering the laboratory. To maintain calm in the experimental process. Achieves the operation earnestly, observation carefully, positive ponder. Records the experimental phenomenon and the empirical data truthfully.

(3) Take care on state property. Uses the instrumentation and equipment carefully. Saves the drugs electricity and the water.

(4) In the laboratory bench instrument should neatly place at the suitable and position, and maintain the floor neat. Do not have the scrap paper, match sticks, damage glassware and so on to throw into the water trough in order to avoid stops up.

(5) When uses the precise instrument, it must strictly carry on the operation according to the working instruction. If the instrument has been destroyed, it should stop to use and report immediately to instruct teacher, promptly fixes the breakdown.

(6) After experiment, clean the used instrument neatly and return test apparatus in the cabinet. If it is damaged, promptly registered. And inspected by the teacher and registered on the primitive minute book, then leave the laboratory.

(7) After every test the student, being on duty for the day in turn is responsible for cleaning up the laboratory, inspecting the switch of water and electricity, and fastening the window. To maintain the laboratory neatness and its insecurity.

(8) After completing the experiment, the data should process earnestly and write the test report according to the primary record and related theoretical knowledge. Let the teacher to inspect on time.

The laboratory safety regulation

In chemistry experiment, some in flammable, explosive, violent, corrosive chemicals are contacted frequently. Some chemical reactions also have the risk. It uses frequently the water, electricity and many kinds of heating up the lamps and lanterns (such as

alcohol lamp, gas lamp and so on). Therefore, when carries on chemistry experiment, the security problem must fully be taken in mind. Before experiment, understanding fully related security matters and take gread care to it. In the experimental process, observes the working instruction strictly in order to avoid the accident occurs.

(1) Every experiment of producing irritant, odor, violent gas should be carried on in the ventilation chamber(or ventilating place).

(2) The concentrate acids and alkali possess strong corrosiveness, these must be need carefully, be sure not to splash on clothes, on the skin and the eye. On diluting strong sulfuric acid, the acid should pour in slowly into the water with stirring , but water cannot pour into in the strong sulfuric acid.

(3) The virulent drugs (for example lead salt, arsenic compound, specially fluoride) cannot be entered into the mouth or the contact wound. These cannot be casually pour into the sewer and should pour into the vessel according to the teacher as requested.

(4) On heating up the test tube, never face any orifice of the test tube, also cannot overlook the liquid on heating to guard against the liquid to splash or offend somebody.

(5) It is not allow to handle solid drugs with the hand directly. When smells the gas, the nose cannot treat the bottle mouth or the orifice directly, but apply gently few gas to nostril carefully.

(6) Uses the alcohol lamp along with the spot. Strictly prohibits lighting other lamps with the burning alcohol lamp, in order to avoid the ethylalcohol flows out and catches fire.

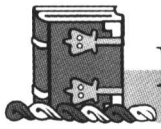
(7) Uses the flammable and explosive drugs, strictly observes the working instruction, be far away the open fire.

(8) Does not allow to mix each kind of chemicals arbitrarily, in order to avoid possibly accident.

(9) The water, electricity, coal gas should be close immediately after use.

(10) In the laboratory, smoking and the diet should be strictly prohibits. After the experiment ended, cleans both hands and then leaves the laboratory.

Li Gairu



EXPERIMENT REPORT FORMAT

Experiment objective:_____ **Score**:_____

Profession, class:_____ **Name**:_____

Experiment date:_____ year _____ month _____ day

1. Experiment objective

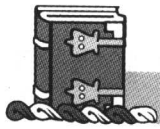
2. Experiment principle

3. Experiment procedure

4. Experiment data recorded and the result expressed

5. Discuss

6. Questions



EXPERIMENT ONE

Weighing Exercise

Objectives

1. Exercise the correct weighing method: direct weighing, weighing by difference, weighing substance of fixed weight.

2. Learn to use analytical balance correctly.

Principle

The analytical balance is a first-class leve apparats to compare two masses. The principle of operation is based on the fact that at balance $M_1L_1 = M_2L_2$ (M_1 represents the unknown mass, M_2 represents a known mass, L_1 and L_2 represent arm length). As the two arms are constructed to be of the same length, therefore, at balance $M_1 = M_2$. A pointer is placed on the beam of the balance as an indicator when a state of balance is achieved. Before the operator adjusts the value of M_2 the balance should be unloaded until the pointer returns to its original position on the scale.

Equipment

Balance, a weighing bottle, a beaker (50mL or 100mL) or a conical flask(250mL).

Chemicals

NaCl.

Procedures

1. Direct weighing: place the object on the balance, and weigh it directly.

2. Weighing by difference: the sample in the weighing bottle is weighed and then a portion is removed (e. g., by tapping) and quantitatively transferred to a vessel appropriate for dissolving the sample. The weighing bottle and the sample are then reweighed and the weight of sample is obtained from the difference. The weight of the next sample can be obtained by repeating the process.

3. Weighing an object of fixed weight: weigh the weighing paper (or weighing bottle, small beaker and so on) alone on the balance, then add sample with a clean spatula. Weigh the sample plus weighing paper. Subtract the weight of weighing paper to obtain the weight of the sample. This method is only valid for samples that do not absorb water from the air on standing.

Notes

1. Never place chemicals directly on the balance, but weigh them in a vessel (weighing bottle, weighing dish) or on filter paper. Always brash spilled chemicals off immediately with a soft brush.

2. Always close the balance case door before weighing. Air currents will cause the balance unsteady.

3. Weigh at room temperature, avoid air convection currents.

Questions

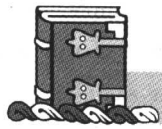
1. How to use significant figures in a weighing calculation?

2. How to weigh an object accurately and quickly?

3. In weighing by difference, do the zero point need to be set? Why?

4. Does the weight the weighing bottle lost exactly equal to the weight the beaker increased? Where does the difference come from?

Ainiwaer



EXPERIMENT TWO

Acid-base Titration

Objectives

1. Practice the operation of titration.

2. Determine the concentration of sodium hydroxide solution and hydrochloric acid solution (mol/L).

Principle

The concentration of an acid or a base can be determined with the acid-base neutralization reaction. The most obvious application of neutralization method is to determine the amount of a base by titrating a measured amount of an acid. With the volume of the base added V_b and the original volume of the acid V_a and the concentration of acid C_a already known, we can calculate the concentration of base C_b.

$$C_a V_a = C_b V_b$$

Whereas, C_a can be calculated from V_a, V_b and C_b.

The equivalent point of the titration can be located by the color change of the acid-base indicator.

In this experiment, titrate the oxalic acid of exactly known concentration with NaOH solution, the concentration of NaOH can be obtained, then titrate the chloric acid with that NaOH solution, so the concentration of chloric acid can be obtained.

Equipment

Burette, pipette.

Chemicals

NaOH solution, HCl solution, oxalic acid standard solution, phenolphthaleins

Procedures

Standardizing the concentration of NaOH solution

Clean up the basic burette rinsed with distilled water and with NaOH solution for

three times. Keep the burette level and carefully rotate it then let drop the solution out from the tip of the burette so that interior surface are wetted. After that, fill NaOH solution into it, drive away the air bubble in the rubber tube and its tip, then adjust the place of the liquid level to "0.00".

Add 20.00mL oxalic acid standard solution with transfer pipette to Erlenmeyer flask, then add 2—3 drops of phenolphthalein indicator, shaking constantly.

Extrude the glass ball in rubber tube to make the liquid dropping to Erlenmeyer flask. The dropping velocity can be quick at the beginning, but afterwards the operation should be controlled drop by drop and avoiding a current of liquid. When the base solution drops into the Erlenmeyer flask, part of the solution appears pink, but the color will disappear quickly while shaking the Erlenmeyer flask. pink color disappears slowly near the end-point. In this period the base solution should be added a drop at a time and allow a half drop of liquid hanging on the tip. It should not fall directly only make it touch the inner wall of the Erlenmeyer flask and then shake. If the pink color doesn't disappear in about half a minute, it means that the end-point is located. Wait a moment, then record the place of the liquid level left in the burette.

Titrate the oxalic acid standard solution with NaOH solution twice using the above method. The difference between the base volume added in every titration should be no more than 0.10mL.

You must pay attention to the following points:

(1) There should not be some droplet left out side the tip of burette and also there should not be some air bubbles left inside the tip when the titration is over.

(2) The color of the solution after the location of the end-point will disappear because of the effect of CO_2 in the open air. That doesn't mean the acid-base reaction is not complete.

(3) During the titration, the base may splash down the upper part of the wall of the Erlenmeyer flask and the last half drop is touched by the wall, so in the immediate vicinity of the end-point it is appropriate to rinse down before completing the titration.

Determining the concentration of HCl solution

Clean up the acidic burette rinsed with the distilled water and with HCl solution for three times. Then fill in the HCl solution and adjust the place of liquid level to "0.00"mL.

Add 20.00mL HCl solution to the Erlenmeyer flask from the acidic burette, then add 2—3 drops of phenolphthalein. Titrate it with NaOH solution according to the above operation. If an excess amount of NaOH is added, you can add HCl solution from the acidic burette until the red color disappears. Then titrate again. Record the volume of

HCl solution and NaOH solution added at the end-point.

Data result

1. Standardizing the concentration of NaOH solution(Table 1):

Table 1 Data result

experiment number	1	2	3
volume of NaOH/mL			
volume of oxalic acid/mL			
concentration of oxalic acid/(mol · L^{-1})			
concentration of NaOH/(mol · L^{-1})			
the average concentration of NaOH/(mol · L^{-1})			

2. Determining the concentration of HCl solution(Table 2):

Table 2 The concentration of HCl solution

experiment number	1	2	3
volume of NaOH/mL			
volume of HCl/mL			
concentration of HCl/(mol · L^{-1})			
the average concentration of HCl/(mol · L^{-1})			

Instructions

Requirements

(1) Go over the theory of acid-base neutralization reaction.

(2) Pay much attention to prepare how to wash the transfer pipette and how to operate with burette in "The basic operations in experimental inorganic chemistry".

(3) How to wash transfer pipette? Why should we clean it up with the solution filled in? Should we clean up the burette and erlenmeyer flask in the same way?

(4) Why should we drive away the air bubbles in the tip of the burette before filled in the liquid? If not, what's the result on reading the volume of the liquid?

(5) If some droplet is left outside the tip of burette after the titration, and some drops are splashed down on the wall of Erlenmeyer flask but not being rinsed with the distilled water, what's the effect on the result?

Operation

(1) Learn how to use the burette and the transfer pipette.

(2) Grasp the operation of acid-base titration.

Notes

(1) Smear some Vaseline on the two sides of the stopcock of the acidic burette and then insert the stopcock into the barred and rotate it vigorously. The burette should be liquid-tight. Take care not to smear the whole stopcock, otherwise the hole will be jammed.

(2) Steep the burette and the transfer pipette in hot chromic acid solution for about 10 minutes, then the chromic acid should be poured back to the original bottle. Because chromic acid is poisonous, so do not pour it to the sewer.

(3) Wash the burette and transfer pipette with tap water and distilled water, then clean up them with the solution that will be filled in.

(4) Place a forefinger of your right hand over the upper end of the pipette, then carefully fill the pipette somewhat past the graduation mark employing a suction bulb.

(5) Allow the liquid in the transfer pipette to flow out, it's better to leave the tip of transfer pipette to the inner wall of the Erlenmeyer flask for 30s, then take it away.

(6) Fill the standard solution into the burette to the place above the zero mark, then lower the level of the solution to "0.00"mL, after driving away the air bubbles in the rubber tube and the glass tip.

(7) The dropping velocity may be controlled a little quicker at the beginning of the titration. At this moment the pink color of the indicator will disappear immediately; near the end-point; pink color disappears slowly, It must titrate a drop at a time until pink color doesn't disappear in half minute. It means the end-point is located.

(8) No drop should be left outside the tip after the titration is over. The Erlenmeyer flask may be tipped with distilled water and rotated it so that the bulk of the liquid picks up any droplets adhering to the wall.

(9) Some droplets may be splashed down the wall of the Erlenmeyer flask during the titration, a little amount of distilled water from the washing bottle should be pressed to rinse the inner wall while approaching the end-point.

Report format

(1) Objectives.

(2) Principle.

(3) Record data and result dealing with:

(a) The standardization of the concentration of NaOH solution (Refer to the content and list with table shown in one or same page).

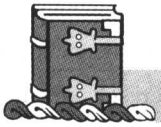
(b) The determination of the concentration of HCl solution (Refer to the content

and list with table shown in one or same page).

Questions

(1) When titrating an acid with a base, does the color of the solution disappear again after the end-point is located if the indicator is phenolphthalein?

(2) The reason for error in this experiment.



EXPERIMENT THREE

The Preparation and Standardization of 0.1 mol/L Hydrochloride Acid Solution

Objectives

1. Master the principle and method of using sodium carbonate (Na_2CO_3) as the primary standard substance to standardize hydrochloride acid solution.

2. Properly judge tile ending point of Methy$_1$ red-bromocresol green as mixed indicator.

Principle

Hydrochloride acid is easy to volatize and the standardized solution can not be prepared directly. So solution of the approximate concentration should be made first, and then standardize it with primary standard substance.

The primary standard substance for standardize acid solution is anhydrous sodium carbonate (Na_2CO_3), or borate etc. In this copy anhydrous sodium carbonate is used as primacy standard substance and methyl red-bromocresol green mixed indicator as the indicator. At the ending point, the color changes from green to purple. The reaction is in the following equation:

$$2HCl + Na_2CO_3 = 2NaCl + H_2CO_3$$

According to the mass of the primary standard substance and the volume of hydrochloride acid consumed, the concentration of hydrochloride acid can be calculated from the following below equation:

$$C_{HCl} = \frac{2w_{Na_2CO_3}(g)}{V_{HCl} \cdot \frac{M_{Na_2CO_3}}{1000}}$$

$$M_{Na_2CO_3} = 105.99 \ (g/mol)$$

Equipment

Drop-burette (25mL), conical flask (250mL), volumetric cylinder (100mL,10mL).