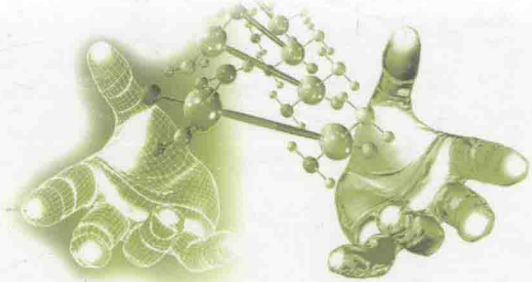
中小学
双语师资培养系列教材

总主编　刘春明

中学化学专业基础英语教程

A Fundamental English Course in Secondary School Chemistry

◎ 王春姣　刘春明 // 主编



东北师范大学出版社
NORTHEAST NORMAL UNIVERSITY PRESS

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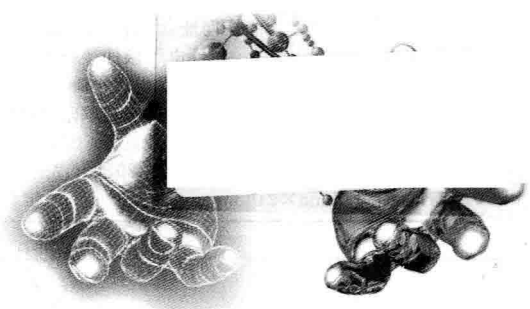
Zhongxue Huaxue Zhuanye Jichu Yingyu Jiaocheng

◎ 王春姣　刘春明 // 主编
◎ 于建军 // 副主编



东北师范大学出版社
长　春

图书在版编目（CIP）数据

中学化学专业基础英语教程/王春姣，刘春明主编.
—长春：东北师范大学出版社，2011.7
ISBN 978-7-5602-7168-2

Ⅰ.①中… Ⅱ.①王… ②刘… Ⅲ.①中学化学课-双语教学-教材 Ⅳ.①G634.81

中国版本图书馆 CIP 数据核字（2011）第 142357 号

□责任编辑：曲 颖 □封面设计：李冰彬
□责任校对：孔垂杨 □责任印制：张允豪

东北师范大学出版社出版发行
长春净月经济开发区金宝街 118 号（邮政编码：130117）
电话：0431—85687213
传真：0431—85691969
网址：http://www.nenup.com
电子函件：sdcbs@mail.jl.cn
东北师范大学出版社激光照排中心制版
吉林省良原印业有限公司印制
长春净月经济开发区小合台工业五区（邮政编码：130117）
2011 年 7 月第 1 版 2011 年 7 月第 1 次印刷
幅面尺寸：148mm×210mm 印张：9.125 字数：237 千

定价：**20.00** 元

前　言

在世界进入21世纪的今天，中国加入WTO，中国改革开放日趋深化，中国正走向世界，世界也在向中国走来，国家和社会的发展使得对双语人才的需求程度迅速提高。同时，实施双语教育，也是为了满足学生未来发展的需要——学生将来为了科研工作、获取信息、出国深造、在合资企业谋求职业，必须具有双语能力，必须是双语人才。这是国家和社会发展的必然。世界语言的发展趋势使人们越来越相信，人类未来将是一个双语世界。当前，双语教学已成为我国教育改革的热点，越来越多的地区和学校已经实施或准备实施双语教学。然而，双语课程教材的开发却制约着我国双语教育的进一步发展与提高。

结合长春师范学院多年的化学双语师资培养实践经验及化学专业英语教学的实际情况，我们编写了这本教材。该教材由浅入深，使化学知识的学习与专业英语的学习融为一体，既适用于化学双语师资培养的化学专业英语教学或双语教学，也可以作为高等学校及初高中双语教师的参考用书。

全书共分为15个单元，涵盖了化学基本概念、原理、理论、典型元素化合物等内容。每一章节都由相对独立的文章组成，并配有适当的词汇、习题及讲解，以方便读者及时准确地了解和掌握化学专业基础英语词汇及表达方式。

该书由王春姣、刘春明教授主编并审核修订，其中于建军完成第1，第2单元，刘春明完成第3单元，王春姣完成第4—15单元。本教材在编写过程中，参阅了大量国内外资料和文献，在此向这些资料和文献的原作者及编者致以诚挚的谢意。

限于经验与水平，教材中不足之处在所难免，敬请读者批评指正，以便进一步改进和完善。

编　者

2011年6月

CONTENTS

Unit 1 States of Matter

Goals

After completing this unit, you will be able to:

- describe the states of matter and explain their interconversion
- describe methods of purification by use of a suitable solvent
- suggest suitable purification techniques, given information about the substances involved

New words and expressions

melting point 熔点
boiling point 沸点
freezing point 冷凝点
sublimation 升华
evaporation 蒸发
condensation 冷凝
filtration 过滤
filter paper 滤纸

residue 滤渣
filtrate 滤液
centrifuge 离心机
suspension 悬浮液
crystallization 结晶
distillation 蒸馏
miscible 易混合的
fractional distillation 分馏
decant 倾倒

Warming up

Everything you can touch is made of matter. Everything you will learn in Chemistry will all be based on how matter reacts and combines. Matter is the stuff around you.

(a) What are the three states of matter?

(b) What are the differences between the three states?

(c) Please describe the changes of the three states.

Reading

1. The states of matter

All substances are matter. This includes the air, sea, Earth, all living creatures and even the sun and stars. **Matter** is anything that has mass and takes up space. There are three main states of matter: solid, liquid and gas. These three forms are called the

states of matter.

Table 1.1 Differences in the properties of the three states of matter

Physical state	Volume	Density	Shape	Fluidity
Solid	has a fixed volume	high	has a definite shape	does not flow
Liquid	has a fixed volume	moderate to high	no definite shape—takes the shape of the container	generally flows easily
Gas	no fixed volume—expands to fill the container	low	no definite shape—takes the shape of the container	flows easily*

* Liquids and gases are called fluids. (fluid: a substance which flows and is not solid)

2. Changes in physical state

☆ Melting and freezing

a. melting point

The temperature at which a pure substance turns to a liquid is called the melting point (m. p.). This always happens at one particular temperature for each pure substance.

b. freezing point

The process is reversed at precisely the same temperature if a liquid is cooled down. It is then called the freezing point (f. p.).

The melting point and freezing point of any given substance are both the same temperature. For example, the melting and freezing point of pure water take place at 0℃.

☆ **Sublimation**

A few solids—carbon dioxide (dry ice) and iodine, for example—do not melt when they are heated. Instead they turn directly into gas. This change of state is called sublimation: the solid sublimes. Like melting, this also happens at one particular temperature for each pure solid.

☆ **Evaporation, boiling and condensation**

If a liquid is left with its surface exposed to the air, it evaporates. When liquids change into gases over a range of temperature, the process is called evaporation. Evaporation takes place from the surface of the liquid. The larger the surface area, the faster the liquid evaporates.

The warmer the liquid is, the faster it evaporates. Eventually, at a certain temperature, it becomes hot enough for gas to form within the liquid and not just at the surface. Bubbles of gas appear inside the liquid. This process is known as boiling. It takes place at a specific temperature, known as the boiling point (b. p.) for each pure liquid.

The reverse of evaporation is condensation. This is usually brought about by cooling. However, we saw earlier that the gas state is the one most affected by changes in pressure. It is possible, at normal temperatures, to condense a gas into a liquid by increasing the pressure, without cooling. Sometimes the word vapour is used for a gas that can be compressed into a liquid without cooling.

Pre-reading

(a) What does a pure substance mean?

(b) In real life, very few substances are 100% pure. How can you tell if a substance is pure?

Reading

Separating and Purifying Substances

Many mixtures contain useful substances. The useful substances can be separated from the non-useful (unwanted) ones. In order to obtain these useful substances, chemists often have to separate from the impurities. The methods they use depend on what is in the mixture and the properties of the substances present. It also depends on whether the substances to be separated are solids, liquids or gases.

(1) Separating solid/liquid mixtures

If a solid substance is added to a liquid it may dissolve to form a solution. In this case the solid is said to be soluble and is called the solute. The liquid it has dissolved in is called the solvent.

● Filtration

Filtration is a common separation technique used in chemistry laboratories throughout the world. It is used when a solid needs to be separated from a liquid. The mixture is poured into a piece of folded filter paper. The filter paper has very small holes. The holes allow water and dissolved particles to pass through but not

the larger insoluble particles. The solid that remains in the filter paper is called the residue. The liquid that passes through is called the filtrate. For example, the sand can be separated from a mixture with water by filtering through filter paper as shown in Figure 1. 1.

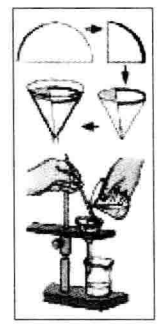


Figure 1. 1 Filtration

The filter paper contains holes that, although too small to be seen, are large enough to allow the molecules of water through but not the sand particles. The sand gets trapped in the filter paper and the water passes through it. The sand is called the residue and the water is called the filtrate. It is important when filtering not to overfill the filter paper.

● Centrifuging

Another way to separate a solid from a liquid is to use a centrifuge. It is usually used when solid particles are so small that they spread out throughout the liquid and remain in suspension. They do not settle to the bottom of a container, as heavier particles would do, under the force of gravity. The technique of centrifuging or centrifugation involves the suspension being spun round very fast in a centrifuge so that the solid gets flung to the bottom of the tube.

Figure 1. 2 Centrifuge

The pure liquid can be decanted after the solid has been forced to the bottom of the tubes. For example, this method of separation is used extensively to separate blood cells from blood plasma. In this case, the solid particles (the blood cells) are

flung to the bottom of the tube, allowing the liquid plasma to be decanted.

● Evaporation

A solid dissolves in a liquid to produce a solution. The solid that dissolves is called a solute. The liquid is called a solvent.

Therefore: solution=solute+solvent

If the solid has dissolved in the liquid it cannot separated by filtering or centrifuging. Instead, the solution can be heated so that the liquid evaporates completely and leaves the solid behind. The simplest way to obtain salt from its solution is by slow evaporating.

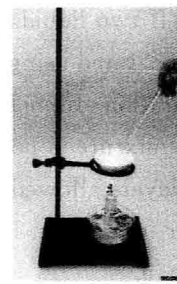


Figure 1.3 Evaporation

● Crystallization

Crystallization separates a solid from a solution. When no more solute can dissolve, the solution is said to be saturated. Extra solid remains undissolved at the bottom of the container. When a solution is heated, most of the solvent evaporates off. The hot solution is then allowed to cool. Because a hot solution can dissolve a large amount of a substance than a cool solution, the solution contains more solute than it can dissolve as it cools. Therefore the solution becomes saturated and the dissolved solid now appears as pure crystals. The impurities remain in the solution.

● Simple distillation

Simple distillation separates a pure liquid from a solution. When a solution is heated, the solvent evaporates. When the hot vapour condenses, a pure liquid is obtained. The liquid collected is called distillate. The solute does not evaporate but remains in the

original solution.

(2) Separating liquid/liquid mixtures

● Liquids which are immiscible

If two liquids are immiscible they can be separated using a separating funnel (or separation funnel, separatory funnel). The mixture is poured into the funnel and the layers allowed to separate. The lower layer can then be run off by opening the tap.

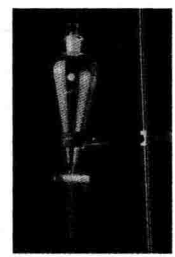


Figure 1.4 a separating funnel

● Liquids which are miscible

If miscible liquids are to be separated, then this can be done by fractional distillation. Fractional distillation separates mixtures of miscible liquids. Some liquids mix together well to form a single solution. The liquids are said to be miscible. For example, ethanol and water are miscible. The mixture can be separated by fractional distillation if the boiling points of the liquids are different. The separated liquids are fractions.

Figure 1.5 shows the mixture is placed in the flask and small pieces of anti-bumping granules are put into flask to make the boiling smooth. For example: the separation of water and ethanol by fractional distillation. The boiling point of ethanol and water are 78℃ and 100℃ respectively. A liquid with a low boiling point evaporates easily. Therefore ethanol evaporates more readily than water.

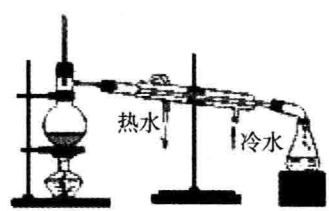


Figure 1.5 fractional distillation

This difference makes the separation possible. The flask is

heated slowly and the mixture boils. The vapour from the boiling mixture moves up the fractionating column. In the fractionating column, the glass beads provide a large surface area for the vapour to condense. Water vapour condenses more easily. Most of the water vapour condenses on the glass beads and drops back into the flask. Therefore, ethanol in the vapour gradually separates from the water in the vapour. By the time the vapour reaches the top of the fractionating column, it is almost pure ethanol. The vapour passes into the condenser and condenses into liquid ethanol. The thermometer reads 78℃ while the ethanol is being distilled.

When most of the ethanol has boiled off, the escaping vapour consists of almost pure water. As water has a higher boiling point than ethanol, the temperature is being distilled. In fractional distillation, a complete separation of the miscible liquids is difficult. Thus the ethanol in fact, still contains small amounts of water.

Grammar and expressions

1. Mixture: A system of two or more substances that can be separated by physical means. E. g. sea water.

2. Pure substance: consist of one substance only—it has no contaminating impurities.

3. The filter paper has very small holes. The holes allow water and dissolved particles to pass through but not the larger insoluble particles.

滤纸表面有无数小孔可供液体粒子通过，而体积较大的固体粒子则不能通过。

4. Small pieces of anti-bumping granules (glass beads or broken china) are put into the flask to make the boiling smooth.

在蒸馏烧瓶中放少量碎瓷片，防止液体暴沸。

Post-reading

1. Write down two properties of a solid, two of a liquid, and two of a gas.

2. Which has a higher boiling point, oxygen or ethanol?

3. When seawater is filtered, the filtrate is salty. Why?

4. How is fractional distillation:

(a) similar to, and (b) different from simple distillation?

5. Describe how you would crystallize potassium nitrate from its aqueous solution.

Integrating skills

1. Devise a method for obtaining salt from sea water in the school laboratory.

2. Explain how fractional distillation works.

3. Name the method which is most suitable for separating the following:

A. oxygen from liquid air

B. red blood cells from plasma

C. petrol and kerosene from crude oil

D. coffer grains from coffee solution