普通高等教育“十一五”国家级规划教材

全国高等医药院校药学类实验双语教材

QUANGUO GAODENG YIYAO YUANXIAO YAOXUELEI SHIYAN SHUANGYU JIAOCAI

物理学实验与指导

（第二版）

主编 陈 曙

EXPERIMENT AND GUIDE FOR GENERAL PHYSICS

(Second Edition)

中国医药科技出版社

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内容提要

本书共收载20个基本物理实验，详细介绍每一个实验的实验目的、实验器材、实验原理、实验内容、数据处理等，附有思考题，还有实验指导。既注重实验本身的训练，同时注意对学生实验规范的训练。适合药学及相关专业本科一年级学生使用。

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出 版 说 明

全国高等医药院校药学类专业规划教材是目前国内体系最完整、专业覆盖最全面、作者队伍最权威的药学类教材。随着我国药学教育事业的快速发展，药学及相关专业办学规模和水平的不断扩大和提高，课程设置的不断更新，对药学类教材的质量提出了更高的要求。

全国高等医药院校药学类规划教材编写委员会在调查和总结上轮药学类规划教材质量和使用情况的基础上，经过审议和规划，组织中国药科大学、沈阳药科大学、广东药学院、北京大学药学院、复旦大学药学院、四川大学华西药学院、北京中医药大学、西安交通大学药学院、山东大学药学院、山西医科大学药学院、第二军医大学药学院、山东中医药大学、上海中医药大学和江西中医学院等数十所院校的教师共同进行药学类第三轮规划教材的编写修订工作。

药学类第三轮规划教材的编写修订，坚持紧扣药学类专业本科教育培养目标，参考执业药师资格准入标准，强调药学特色鲜明，体现现代医药科技水平，进一步提高教材水平和质量。同时，针对学生自学、复习、考试等需要，紧扣主干教材内容，新编了相应的学习指导与习题集等配套教材。

本套教材由中国医药科技出版社出版，供全国高等医药院校药学类及相关专业使用。其中包括理论课教材82种，实验课教材38种，配套教材10种，其中有45种入选普通高等教育“十一五”国家级规划教材。

全国高等医药院校药学类规划教材

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2009年8月1日

序

实验教学是高等药学院校最基本的教学形式之一，对培养学生科学的思维与方法、创新意识与能力，全面推进素质教育有着重要的作用。飞速发展的科学技术，已成为主导社会进步的重要因素。高等药学院校必须不断更新教学内容，以学科发展的前沿知识充实实验课程内容。

近年来，中国药科大学坚持以研究促教改，通过承担教育部“世行贷款——21世纪初高等教育教学改革项目”及立项校内教改课题等多种方式，调动了广大教师投身教学改革的积极性，将转变教师的教育思想观念与教学内容、教学方法的改革紧密结合起来，取得了实效。此次推出的国家“十一五”规划教材——药学专业双语实验教学系列，是广大教师长期钻研实验课程教学体系，改革教学内容，实现教育创新的重要成果。他们站在21世纪教育、科技和社会发展趋势的高度，对药学专业实验课程的教学内容进行了“精选”、“整合”和“创新”，强调对学生的动手能力、创新思维、科学素养等综合素质的全面培养。这套教材具有以下的特点：

1．教材将各学科的实验内容进行了广泛的“精选”，既体现了高等药学教育“面向世界、面向未来、面向现代化”，也考虑到我国药学教育的现状与实际；既体现了各门实验课程自身的独立性、系统性和科学性，又充分考虑到各门实验课程之间的联系与衔接，有助于学生在教学大纲规定的实验教学学时内掌握基本操作技术，提高动手能力，养成严谨、求实、创新的科学态度。

2．教材中新增的综合性、设计性实验有利于学生全面了解和综合掌握本门实验课程的教学内容。这一举措既满足了学生个性发展的需要，更注重培养学生分析问题、解决问题的能力和创新意识。

3．教材中适当安排一些反映药学学科发展前沿的实验，有利于学生在掌握实验基本技术的同时，对药学学科的新进展、新技术有所了解，激发他们学习药学知识与相关学科的兴趣。

4．教材以实践教学为突破口，采用双语体系编写，为实验课程改革构建数字化、信息化和外语教学的平台，有利于提高学生的科技英语水平。通过我校多年的药学系列实验课程双语教学实践，证明学生完全能够接受此套教材的教学。

国家十一五规划教材——药学专业双语实验教学系列教材的陆续出版，必将对推动我国高等药学教育的健康发展，产生积极而深远的影响。由于采用双语体系编写药学教学实验丛书尚属首次，缺乏经验，在内容选择及编写方法上的不妥之处，在所难免。欢迎从事药学教育的同行们批评赐教。

吴晓明

（中国药科大学校长、博士、教授、博士生导师）

Preface

Experimental teaching is one of the most fundamental teaching means in pharmaceutical colleges, 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. Fast-advancing science and technology has come to be an important factor in dominating social progress. Teaching materials must be updated continually in pharmaceutical colleges, especially enriching the materials of experimental courses with the most advanced knowledge in the subject.

In recent years, China Pharmaceutical University have been stressing the promotion of teaching reform on the basis of research, succeeding in stimulating teachers' enthusiasm for teaching reform by various means such as undertaking the project of teaching reform in higher education at the beginning of 21st century sponsored financially by World Bank and entrusted by the Ministry of Education as well as approving and ratifying internal programs on teaching reform. Meanwhile, it yields fruits to integrate the transforming of teachers' educational ideology into the reform of teaching materials and methods. This series of textbook of national "11th five" planning-bilingual pharmaceutical experimental teaching series, is an important achievement made through studying ueaching system of experimental courses for long, reforming teaching materials and carrying out educational innovation of all the teachers concerned.

Meeting the new demands for education, science and technology and social growth, they select, integrate and innovate the teaching materials of pharmaceutical experimental courses, stressing the overall cultivation of comprehensive qualities, including experimental ability, creative thought and scientific attainments. This set of textbook possesses the following features:

1. These textbooks make an extensive "selection" of the experimental materials of each subject, reflecting the goal of facing the world, facing the future and facing the modernization in higher pharmaceutical education, and taking into account the status quota and reality of our pharmaceutical education; meanwhile embodying the individuality, systematicness and scientificalness of each experimental courses, which helps the students to grasp basic techniques of operation within the class hours of experimental teaching pre-

scribed by teaching syllabus and to improve their experimental ability and finally to cultivate a scientific approach of precision, practicality and creation.

2. The comprehensive designing experiments newly supplemented in the textbooks help the students to learn totally and grasp comprehensively the teaching materials of the experimental courses, which not only meets the students' needs for individual development but also trains their ability to analyze and solve problems and cultivates their creative consciousness.

3. Some experiments representing the latest development in pharmacy are properly included in the textbooks, which helps the students to learn about new advance and technology in pharmacy and to further arouse their interests in studying pharmacy and relevant subjects while grasping some basic techniques of experiment.

4. The textbooks take experimental teaching as starting point and are compiled in a system of bilingualism and aim to set up a platform of digitalization, information and foreign language teaching for the purpose of reforming experimental courses, which serves to enhance the students' level of technological English. It has been proved that the students have no difficulty being adapted to the teaching of this set of textbook through many years of bilingual teaching practice carried out in a series of pharmaceutical experimental courses of our university.

The successive publishing of the series of textbooks used for bilingual pharmaceutical experimental teaching-the national "11th-five" planning textbooks, will surely produce good and far-reaching influence in promoting the sound development of higher pharmaceutical education of our country. Since it is the first time that we have compiled this series of textbook of pharmaceutical teaching experiment in a bilingual system, we lack experience and thus some defects in choice of materials and way of compilation are inevitable. Experts engaged in pharmaceutical education are welcome to give any criticisms and advice.

Wu Xiaoming

Ph. D, prof., and supervisor of doctoral candidates
President of China Pharmaceutical University

第二版前言

本书自2005年3月第一版出版以来已经4年多了。这些年以来编者一直比较注意本书在使用中的反响，也很关注国内同类高校的物理理论和实验教学的状况，第二版依然优先考虑实用性和适用性。这次编写工作主要着重于以下几个方面。

1. 整合了一些实验，删除了两个实验，新增了两个实验，从原来22个实验调整为20个实验。作为实验教材不是手册性的书籍，不能讲究大而全。教师好教学生好用应是教材的基本出发点。注重基本知识学习和基本技能训练才是本课程的主要任务。

2. 中英文完全做到了一一对应。学生完全可以按照英文部分完成实验。几年来的教学实践表明双语物理实验对大学生在用英语准确地获取科技信息方面、操作指导和书写表达方面都是有帮助的。双语实验教学对教和学两个方面都是有益的。

3. 每个实验前均做了一些简要的介绍，修改了一些错误和不恰当的地方。

参加本书编写的有陈曙、周春红、王众虎、蒋岩玲、姚峥嵘、尹媛、韩东强、马骄和黄耀庭。他们都是长期参加物理实验教学的老师，有着较为丰富的教学经验。马军老师为本书的用图做了许多工作，施雪娟老师对本书的编写也给予了许多帮助。

这些年来使用本书的学生提出了许多意见和建议，特此表示感谢。美国加州大学伯克利分校的刘冰教授、中国药科大学的国际留学生等都对本书的英文编写给予过帮助。还要感谢中国药科大学教务处的领导为本书做的组织工作，他们一直鼓励双语教材的编写。

本书一定还有不妥或错误的地方，有待将来在使用中改过和改进。

陈　曙

2009年4月

Preface to the Second Edition

It has been more than 4 years from the publication of the 1st edition of this text book. During these years we have been paying a lot of attention on the response of this book and the situation of teaching and learning of physics course in the similar colleges in China. A much more consideration on the rewriting work of this 2nd edition is paid on practicability and applicability. We emphasize main work as following.

1. Some of the experiments have been combined. Two experiments have been omitted and two new have been added in. Totally there are 20 experiments in this 2nd edition other than the 22 in the 1st edition. As a lab text book it is not a handbook or a dictionary. The essential basis for a text of fundamental course is its practical purpose for students as well as teachers. The main role of physics lab course is to learn fundamental knowledge and basic abilities.

2. The English version is completely corresponding to its Chinese text. Students can find its English version working as Chinese. These years the practice of bilingual teaching is showed helpful for students not only obtaining accurate scientific information but also correct operation as well as written expression.

3. A brief introduction is given before every experiment. Some of the errors and unsuitable expression have been modified.

The writers of this edition are Chen Shu, Zhou Chunhong, Wang Zhonghu, Jiang Yanling, Yao Zhengrong, Han Dongqiang, Ma Jiao and Huang Yaoting. They are all working as lab instructors for many years and have good understanding on the physics lab course. Ma Jun has done some of the drawing work and Shi Xuejuan has done a lot of assistant work for this edition.

I am delight to acknowledge the readers of the 1st edition for their practical and creative suggestions. Professor Liu Bing of University of California at Berkeley and the international students of China Pharmaceutical University are all helpful to the English version. I wish to express my appreciation to the officials of the Teaching Administration Bureau of China Pharmaceutical University, they are all enthusiasm for the publication of bilingual text books.

There could be incorrectness in this book which should be corrected in the further editions.

Chen Shu
April, 2009

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绪　论

物理实验在物理学的发展过程中一直起着重要的和直接的推动作用。同时，物理实验也为其他学科、技术的发展提供了有力的方法和工具。作为一名理科学生，通过对物理实验课程的系统学习，必然会给后期其他课程的学习打下良好的基础。

一、教学要求

物理实验是一门独立设置的课程。开设这门课程的主要目的是培养学生具有良好的实验素养、基本实验技能、理论联系实际和独立工作的能力。以下是本课程的一些基本教学要求：

1. 在物理实验的基本知识、基本方法和实验技能方面受到较为系统的训练。

2. 学习如何认识实验思想、实验方案，正确使用基本仪器，掌握基本测量技术，正确分析实验数据，分析实验结果。

3. 培养严肃认真、实事求是的科学态度和工作作风。

二、教学环节

物理实验是学生在教师指导下独立进行的一种实践活动。学生是实验的主要完成者。一般说来，每个实验都有三个教学环节：预习、进行实验和完成实验报告。

1. 预习实验

仔细阅读实验教材，了解实验原理、方法和步骤。大致了解实验仪器的使用方法、实验中可能出现的一些现象。在此基础上，要写出实验预习报告。实验预习报告要包括实验目的、实验原理简介，实验步骤，实验用示意图，实验数据记录表格等项目。

2. 进行实验

实验时应遵守实验室规章制度。在教师指导下正确使用仪器。实验进行时，应合理操作，仔细观察，认真思考。在预习报告本上正确记录实验现象、实验数据。不要用铅笔记录数据。正确的删除或改正实验数据的方法是，可以用笔划去，再注明原因。在电磁学实验中，连接好实验线路后，应自己先检查一遍，再由指导老师检查，如正确无误，方可接通电源继续实验。

3. 实验报告

实验报告是实验者对实验情况的书面报告形式，一般应做到字迹清晰，文理通顺，逻辑合理。报告中的示意图要按照具体要求，用直尺或曲线板辅助画出。对实验现象、结果的分析讨论要有理并符合实际情况。

一般说来，实验报告应包括以下几个部分。

（1）实验名称、实验者姓名、实验日期。

（2）实验目的。

（3）实验原理。要求叙述简要。

（4）实验仪器器材。要记录名称、型号、规格、编号等。

（5）实验步骤及数据。记录数据一定要用表格形式，数据计算过程要简洁明了。

（6）实验结果及讨论。分析有关实验现象及实验结果，提出对实验中存在的一些问题的解决方案或建议，回答思考题，等。

对有特殊要求的实验报告，按具体要求完成。

最后，需要特别提醒的是安全。一旦发现异常现象，要立即切断电源、火源、气源，并报告指导老师，有必要时要拨打“119”火警电话。

Introduction

Physics experiment is an important part of physics science; it also plays a determined and propulsive role of the physics science. There are a lot of physics experimental methods and tools, which have been widely applied in the areas other than the physics science. As a science student, it is really helpful to be trained systematically in this lab course.

Learning Requirement

1. Learn to know the basic knowledge and methods of physics as well as experimental skills.

2. Learn to get a clear opinion of every experiment plan and technique. Operate the apparatus correctly. Learn to study and analyze the experimental data to get proper conclusion.

3. It is a right manner for a science student to be practical and realistic.

Lab Process

General speaking, there are three steps for one experiment:

1. Preparation

Read the text or other reference to understand the experiment principle and main method. Get a clear idea about the apparatus and experiment phenomenon. Write a preparation report which should include such items as objectives, principle, apparatus, steps, data tables, and so on.

2. Experiment

It is important to obey the lab bylaws. Your instructors may give you some necessary experimental instruction and explaining. You should try to be patient, careful and considerate. Record the lab phenomenon and data on you own book with a pen. Some electric circuits you joined should be checked by you instructor before switching on electric power.

3. Experiment Report

The paper report of your experiment should be clear and methodic. Usually an experiment report should include the following items:

(1) The experiment title, your name and date.

(2) Experiment objectives.

(3) Principle (briefly introduced).

(4) Lab apparatus, with name, type, specification, serial number, etc.

(5) Experiment process and data. All the data should be recorded into suitable tables, and make the data processing being concise.

(6) Experiment results and discussing. The results and some phenomenon maybe discussed according to your experiment. If you have any suggestion you may put forward here. Usually there are some questions you should answer.

For any other special requirement, your report should be written in the form as your text claimed.

Please keep safety always in your mind. If there is anything abnormal, first you should cut off the electric power, gas or water supply, and then report you lab instructor. The emergency telephone number in our city is "119".