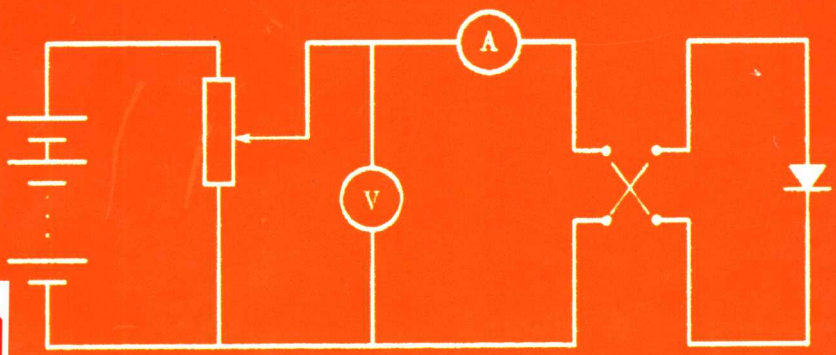
英汉双语教材

英汉大学物理实验

English-Chinese College Physical Experiment

主　编　刘传安

副主编　杜旭日　王卫林　方传代



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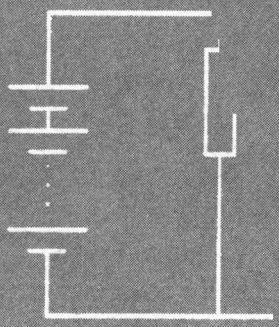

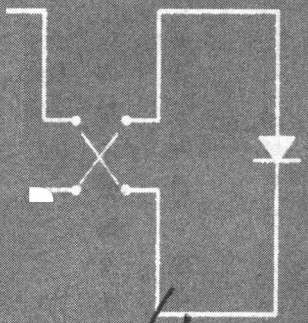

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前　言

普通物理实验是理工科学生必修的一门重要基础课程。物理实验的重要性不仅表现在通过实验发现物理定律，而且表现在物理学中的每一次重要突破都与实验密切相关。物理实验在大学教育中的重要性不言而喻。随着改革开放的深入和我国加入 WTO，物理教学的国际交流日趋频繁，迅速培养既懂业务，又精通外语的科技人才是现代教育的当务之急。近年来，各高校大力提倡双语教学，但物理双语教材严重缺乏，特别是适合一般院校使用的物理实验双语教材更难以找到。为了填补这一空白，我们特编写了本书。

鉴于目前地方院校学生的英语水平参差不齐，为了便于学生学习，我们采用英汉对照编排。在误差数据处理方面，按照现代国际科技文献和实验的结果表述要求，我们采用计算结果的标准不确定度，并选择一些有代表性的实验进行了测量举例。全书共编入实验 50 个，其中力热实验 26 个，电磁学实验 16 个，光学实验 8 个。

全书由刘传安策划和统稿。其中：绪论、测量仪器、力学实验和测量举例部分由刘传安执笔；电磁学实验由杜旭日执笔；热学实验由王卫林执笔；光学实验及部分测量举例由方传代执笔。李翔一为本书提供了英文指导。另外，袁新梅参与了绪论的编译及部分测量举例的数据处理；罗小凤进行了图表的绘制和书稿校对；张山彪、吴春晓也对本书的编写提出了很好的意见。参加本书编写讨论的还有张斌、陈亮、褚玉芳、周珺、吴校习等。

本书可供理科、工科、师范院校物理专业选作物理实验双语教材，也可供理工科、专科院校非物理专业和电大、职大选作物理实验(双语)教材。

本书编写过程中参考了杨述武主编的《普通物理实验》和伯克利《大学物理实验》，此外还参考了许多其他大学教材，在此不一一指明，特致谢意。天津大学出版社为本书的编辑出版做了大量工作，深表感谢。

由于水平有限，书中难免有缺点和错误，恳请读者不吝赐教。

编者

2005 年 8 月

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Introduction

1. General Instructions

1.1 Presentation of Experiments

The method adopted for describing the experiments is usually as follows.

Heading: This is a statement (in **heavy** type) of the principle being investigated, or of the determination being made.

Apparatus: This is a list of the apparatus required, omitting such equipment as is commonly to hand such as balances, metre rules, wire, etc.

Theory: This is usually a short section designed to refresh the memory on relevant theory. Occasionally more detail may be given—in cases where a little more help has been found by experience to be needed.

Procedure: Here the actual experimental instructions are given.

Record and Calculation: In this section suggestions are often made as to how the observations should be set out in a notebook. These suggestions are by no means obligatory, and should be discarded if a different presentation is preferred. Any guidance needed in the calculation is also given in this section.

1.2 Instructions Which Apply to All Experiments

Read the experiment heading carefully and

绪论

1. 一般说明

1.1 实验概述

本书采用下述方法叙述实验。

标题：用黑体字交代所要研究的原理或所要做的测定。

仪器装置：是所需要的仪器的目录，天平、米尺、导线等常用仪器和元件一般不列入。

原理：介绍实验原理，一般比较简短，但是，在经验表明需要给实验者较多帮助的地方则比较详细。

实验步骤：对实验给予具体指导。

数据记录与处理：这部分指出在记录本上怎样记录实验数据。不必拘泥于这些提示，读者可以使用其他更好的方法。此外，在这部分还有必要的处理数据方面的指导。

1.2 适用于所有实验的注意事项

仔细阅读实验标题，

此为试读，需要完整PDF请访问：www.ertongbook.com

be sure that you have grasped precisely what it means. This is a practical book; at times it reminds you of theoretical points, but it does not pretend to deal with them completely. It is assumed that if you are not familiar with the theoretical matter concerning any experiment, you will take the steps necessary to acquire this knowledge before beginning the experiment. Thus, the frequent use of the words "it can be shown" to introduce a formula or expression should be taken as an instruction to find out how it is shown, if this is not already known.

准确理解它的意思。这是一本实践方面的书，书中有的地方提示一些理论要点，但不作系统完整的讨论。如果你不熟悉实验涉及的理论知识，我们设想你在做实验之前会设法去掌握它。因而常用"可以表明"来引出一个公式或表达式。

Read right through all that is given about the experiment, so that you have a clear idea of all that you have to do, the precautions you have to take and the kind of record you have to make.

阅读实验指导全文，对需要做的事情、需要注意的事项及需要做的记录，都能"心中有数"。

Examine the apparatus to be used, and if you have any doubts about any of it ask for a demonstration.

检查要用的仪器，如有疑问应请教老师。

Carry through the operations in the orders that are given, remembering that this book has not been written for those who blunder from one operation to the next without having understood the whole experiment.

按给定的实验步骤进行实验操作。要记住，本书不是为不了解整个实验、只会盲目机械地从一个操作到下一个操作的人写的。

Record all observations in ink in your notebook as you make them.

把观察到的一切数据记在笔记本上。

Put your apparatus away in its proper place when your experiment is finished.

做完实验后，把仪器物品放回原处。

1.3 Your Laboratory Notebook

In your practical notebook, a record of all you do must be kept. The record of each experiment should be started on a fresh page and should normally consist of five main parts:

①The heading together with the date;

②The observations;

③The calculation;

④The account of the method, accompanied wherever appropriate by a diagram. In the case of electrical experiments a circuit diagram is essential;

⑤The statement of result, including the standard uncertainty.

We will consider these five sections in turn.

①The heading should be a concise statement of the aim of the experiment, with perhaps a phrase indicating the method to be used. The date is an important part of the heading.

②The observations should be recorded in ink in your notebook immediately after they are made. This point cannot be overemphasised. The use of loose pieces of paper, and of pencil, is strongly condemned for the following reasons.

(a)It is a waste of time, as all your observations must be presented in the final record.

(b)It is slovenly, and may lead to confusion.

1.3 实验记录本

必须在记录本里记录你所做的一切。每个实验的记录都应从新的一页开始。它应包括5个主要部分:

①实验标题和日期;

②观测数据;

③计算;

④实验方法的有关说明,必要时可画出图表,做电学实验要画出电路图;

⑤实验结果,包括标准不确定度。

下面我们依次说明这5个部分。

①标题应就实验目的作简明的叙述,间或指明所用方法。必须写上实验日期。

②得到观测数据后,立即用钢笔记在记录本上。这点很重要。绝不能使用零散纸张和铅笔,理由如下。

(a)那样做浪费时间,因为所有观测数据最终要记到固定的记录本中。

(b)那样做显得潦草,可能导致混乱。

(c) It may lead to non – scientific methods of working, by giving you the opportunity to select observations which you think superior to those you reject—without giving any reason for this selection. Usually the motive for this is to "get the right answer"—whatever that may mean. Remember that there is no "right answer". Kaye and Laby's tables tell you what more experienced experimenters have found for the values of many important quantities; and it is certainly worth while to see how your answer compares with the generally accepted value. But if you should happen to "agree with it" you are more likely to have been lucky than clever. What you should do is to see whether the accepted result lies within the range of values which you obtained, by considering the error of your experiment.

Do not omit to record the standard uncertainty of each observation and to state the units in which you are working.

③The calculation should be neatly set out and intelligible, so that if necessary it can be checked without your being present to decipher

(c)那样做可能导致不科学的工作方法。因为它使你有机会为了要"得到正确的答案"——不管其含义如何,而去选用你认为较优的某些数据,舍弃你认为较劣的某些数据——而不阐述取舍的理由。要记住,不存在什么"正确答案",通常在教材和资料中引用的重要物理量的公认值,是由许多有经验的实验工作者反复测定的。把你的实验结果与公认值作比较,无疑是有意义的。但是,如果你的结果和它"完全一致",那多半是碰巧而不是你的高明,应该考虑你的实验结果的标准不确定度,从而弄清公认值是否在你得到的结果的标准不确定度之内。

记录中不要遗漏每个观测数据的误差范围,也不要忘记标明所用的单位。

③简洁明了地表述计算过程,以便必要时无须解释就能验算。不要混淆

it. Do not confuse the observations with the calculations. If a table is used to record both observations and some corresponding calculated quantities, make it clear which are the observed values and which are the deduced ones.

There are many specimen tabulations given in this book which will help you to develop your style in this matter. Modify where you think necessary.

④ The description of the procedure has been left until after the observations and calculations, because until you have done the experiment you cannot include any account of the difficulties, etc, which were encountered, and of the methods by which they were overcome. Since the observations must be entered immediately in your notebook, and the calculations naturally follow.

Usually your description will be made clearer and shorter if a diagram is given. Remember that a diagram is not a picture. The test of a good diagram is its simplicity. Introduce only such lines and labelling as are necessary to clarify the point which you are illustrating.

⑤ Conclusions, which should consist of the following:

(a) A comment on any graphs drawn;

(b) A statement of your result, giving the value, the standard uncertainty and the units, paying special attention to the rejection of un-

观测值和计算值。如果在同一表格中同时要列入观测值和计算值的话，务必将它们分清。

本书中有不少作为实例的表格可供参考，你可以根据实际情况适当地修改表格。

④只有在完成实验之后方能写出在实验中遇到的困难和其他现象，以及克服这些困难的方法；观测数据要立即记下来，而计算值紧随其后。

画出图表，往往可以使叙述比较简短而清晰。但图表不等于图画，好的图表都是简单的，即图中只画出为说明问题所必要的直线或曲线，并用必要的标号加以阐明。

⑤结论中应包括下列内容：

(a)解释得到的曲线；

(b)叙述实验结果，给出其数据、标准不确定度和所用单位，特别注意给

justifiable decimal places;

(c) A statement of the accepted value of any universal constant determined, together with the source of reference;

(d) A comment on any discrepancy between (b) and (c), together with suggestions for possible improvement of technique.

If you do not complete an experiment, a statement of the reasons for discontinuing it should be given.

2. Measurement, Error and Standard Uncertainty

2.1 Measurement

Laboratory work in physics involves the use of apparatus to make measurements which can be used for one of two purposes: either to make a definite determination—such as the specific heat capacity of rubber, the focal length of a lens, the resistance of a piece of wire, etc.—or to investigate the validity of a law. In both cases the observations must be faithfully recorded and should be as reliable as possible. It is also necessary to include, in the statement of the result of the experiment.

Measurement means the experimental process of comparing the determined and the standard of a kind. The result of experiment includes the number, unit, and the reliable degree of the result (that is, uncertainty).

出的应当是有效数字;

(c)在测定任何普适常数的实验中,要给出它的公认值,并注明这些公认值引自什么资料;

(d)评论(b)与(c)之间的差异,并提出改进实验技术的建议。

如未能完成实验,应写出中止实验的理由。

2.测量、误差及标准不确定度

2.1 测量

实验室工作要利用仪器进行测量。测量有下列两种用途:或者是测量一个定值,例如测定橡皮的比热容、透镜的焦距、一段导线的电阻等等;或者是验证某一个定律。在这两种情况中,观测结果都必须如实记录,并要求尽量可靠,在叙述实验结果中还必须写出实验的可靠程度。

测量就是将待测量与选作标准的同类量进行比较的实验过程。测量结果包括数值、单位及结果可信赖的程度(用不确定度

Measurement is classified into direct one and indirect one. The former means that the measured value can be read directly from a certain measuring apparatus, e.g. length measured with the ruler, temperature with thermometer. The latter refers to calculated value of the functional relatter of one or several directly-measued value, e.g. the use of the formula: $g = 4\pi^2 L/T^2$ in measuring the acceleration of free fall with simple pendulum where T (the periodic time) and L (the length of the string) are directly measurements, g is indirectly measurement.

2.2 Error

Physical experiment means measurement of some physical quantity. The true value is the real measured physical quantity under a certain objective conditions.

Definition of error is as follows.

$$\delta = x - a$$

$$E_r = \frac{\delta}{a} \times 100\%$$

where δ is absolute error; x is the measured value; a is the true value; E_r is the relative error.

来表示)。

测量分为直接测量和间接测量。可以用测量仪器或仪表直接读出测量值的测量称为直接测量,如用米尺测长度、用温度计测温度等。由一个或几个直接测得量经已知函数关系计算出被测量值的测量称为间接测量,如用单摆测重力加速度 g 时,用公式 $g = 4\pi^2 L/T^2$,式中 T(周期)和 L(摆长)是直接测量值,而 g 是间接测量值。

2.2 误差

物理实验是对一些物理量进行测量,被测的物理量在一定客观条件下的真实大小称为该物理量的真值。

误差的定义是:

$$\delta = x - a$$

$$E_r = \frac{\delta}{a} \times 100\%$$

式中:δ 是绝对误差;x 是测量值;a 是真值;E_r 是相对误差。

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