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978-0-521-27285-8 - Algebra Through Practice: A Collection of Problems in Algebra with Solutions, Sets, Relations and Mappings

T. S. Blyth and E. F. Robertson

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Algebra through practice

**Book 1: Sets, relations and mappings**

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# Algebra through practice

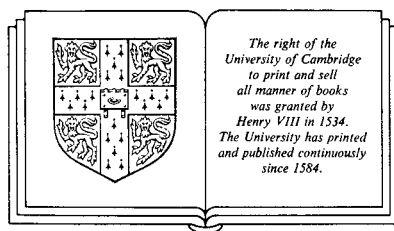
*A collection of problems in algebra with solutions*

## Book 1

# Sets, relations and mappings

T. S. BLYTH ◦ E. F. ROBERTSON

*University of St Andrews*



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## Preface

The aim of this series of problem-solvers is to provide a selection of worked examples in algebra designed to supplement undergraduate algebra courses. We have attempted, mainly with the average student in mind, to produce a varied selection of exercises while incorporating a few of a more challenging nature. Although complete solutions are included, it is intended that these should be consulted by readers only after they have attempted the questions. In this way, it is hoped that the student will gain confidence in his or her approach to the art of problem-solving which, after all, is what mathematics is all about.

The problems, although arranged in chapters, have not been ‘graded’ within each chapter so that, if readers cannot do problem  $n$  this should not discourage them from attempting problem  $n + 1$ . A great many of the ideas involved in these problems have been used in examination papers of one sort or another. Some test papers (without solutions) are included at the end of each book; these contain questions based on the topics covered.

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## Background reference material

Courses on abstract algebra can be very different in style and content. Likewise, textbooks recommended for those courses vary enormously, not only in notation and exposition but also in their level of sophistication. Here is a list of some major texts that are widely used and to which the reader may refer for background material. The subject matter of these texts covers all six books in the *Algebra through practice* series, and in some cases a great deal more. For the convenience of the reader there is given below an indication of which parts of which of these texts is most relevant to the appropriate chapters of this book.

- [1] I. T. Adamson, *Introduction to Field Theory*, Cambridge University Press, 1982.
- [2] F. Ayres, Jr, *Modern Algebra*, Schaum's Outline Series, McGraw-Hill, 1965.
- [3] D. Burton, *A First Course in Rings and Ideals*, Addison-Wesley, 1970.
- [4] P. M. Cohn, *Algebra* Vol. I, Wiley, 1982.
- [5] D. T. Finkbeiner II, *Introduction to Matrices and Linear Transformations*, Freeman, 1978.
- [6] R. Godement, *Algebra*, Kershaw, 1983.
- [7] J. A. Green, *Sets and Groups*, Routledge and Kegan Paul, 1965.
- [8] I. N. Herstein, *Topics in Algebra*, Wiley, 1977.
- [9] K. Hoffman and R. Kunze, *Linear Algebra*, Prentice Hall, 1971.
- [10] S. Lang, *Introduction to Linear Algebra*, Addison-Wesley, 1970.
- [11] S. Lipschutz, *Linear Algebra*, Schaum's Outline Series, McGraw-Hill, 1974.
- [12] I. D. Macdonald, *The Theory of Groups*, Oxford University Press, 1968.
- [13] S. MacLane and G. Birkhoff, *Algebra*, Macmillan, 1968.
- [14] N. H. McCoy, *Introduction to Modern Algebra*, Allyn and Bacon, 1975.
- [15] J. J. Rotman, *The Theory of Groups: An Introduction*, Allyn and Bacon, 1973.
- [16] I. Stewart, *Galois Theory*, Chapman and Hall, 1973.

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*Book 1*

*Background reference material*

- [17] I. Stewart and D. Tall, *The Foundations of Mathematics*, Oxford University Press, 1977.

**References useful to Book 1**

- 1: Sets [2, Chapter 1], [6, Chapters 1, 3], [7, Chapter 1], [17, Chapter 3].  
2: Relations [2, Chapter 2], [6, Chapter 4], [7, Chapter 2], [17, Chapter 4].  
3: Mappings [6, Chapter 2], [7, Chapter 3], [17, Chapter 5].

In [2] the author writes mappings on the right, and uses ‘one-to-one’ for injective and ‘onto’ for surjective. In [6] the author uses  $\subset$  for set inclusion (where we use  $\subseteq$ ). In [7] mappings are written on the right. In [17] the definition of (partial) order differs from ours in that the axiom of reflexivity is missing.