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THE FIRST RESOURCE FOR MATHEMATICS

Skopenkov, Mikhail B.; **Zaslavsky, Alexey A.**

Mathematics via problems. Part 3. Combinatorics. Translated from the Russian by Sergei G. Shubin and Paul Zeitz. (English) Zbl 07768617

MSRI Mathematical Circles Library 29. Providence, RI: American Mathematical Society (AMS); Berkeley, CA: Mathematical Sciences Research Institute (MSRI) (ISBN 978-1-4704-6010-5/pbk; 978-1-4704-7589-5/ebook). xxii, 197 p. (2023)

This third part on combinatorics completes a translation from the original Russian collection of math problems. The first two covered algebra [*A. Skopenkov*, Mathematics via problems. Part 1. Algebra. Translated from the Russian by Paul Zeitz and Sergei G. Shubin. Providence, RI: American Mathematical Society (AMS); Berkeley, CA: Mathematical Sciences Research Institute (MSRI) (2021; Zbl 1465.00001)] and geometry [*A. A. Zaslavsky* and *M. B. Skopenkov*, Mathematics via problems: Part 2. Geometry. Translated from the Russian by Paul Zeitz and Sergei G. Shubin. Providence, RI: American Mathematical Society (AMS); Berkeley, CA: Mathematical Sciences Research Institute (MSRI) (2021; Zbl 1485.00001)]. These books contain sets of problems that are typically discussed in *mathematical circles*. The latter is a Russian concept of groups of enthusiast math lovers forming a mixture of young students and established researchers where interaction is important. They meet to discuss and solve math problems. These problems are not the standard *exercises* where a result can be obtained by applying the standard techniques. What has to be solved are *problems* where the learning element sits in discovering the way to solve them and in a justification of the result so that the answer often includes a proof. So for the younger participants they are like small research projects that are excellent training sets to prepare for a math contest like the Math Olympiads and clearly also for a professional math career.

Practically, the problems are organized in 8 chapters (1. Counting, 2. Finite sets, 3. Graphs, 4. Constructions and invariants, 5. Algorithms, 6. Boolean cube, 7. Probability, 8. Combinatorial geometry) and their subsections, each collecting problems covering a certain topic or solution method. For most, but not all, a solution follows at the end of the section. In principle chapters are independent, but sometimes solutions from later problems can help to solve earlier ones. So, if a problem turns out to be too difficult, the reader is advised to let it rest and return to it later. The sections get a number from 1 to 4 indicating the level of increasing difficulty. On average, this level is also increasing towards the end of the book. The most difficult problems are marked with an asterisk. These and other guidelines provided by the authors, help the reader in how to use the book. Some elementary definitions and a minimum of formality are introduced where needed, but the knowledge assumed is high school mathematics. To start a set of problems, the reader is sometimes referred to the literature to either read more about the technical concepts as well as to get hints about the solution methods. Sometimes the references are the source where the problems were originally published. The 94 references are to the Russian literature, but where possible a pointer to an English translation or an English equivalent are included.

Reviewer: Adhemar Bultheel (Leuven)

MSC:

00-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematics in general
00A07 Problem books
05-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to combinatorics
97-01 Introductory exposition (textbooks, tutorial papers, etc.) pertaining to mathematics education
97K20 Combinatorics (educational aspects)
97K30 Graph theory (educational aspects)

Keywords:

mathematical olympiads; advanced combinatorial problems; Russian mathematics competitions; mathematics circles

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