Methods And Techniques For Proving Inequalities Mathematical Olympiad

Methods And Techniques For Proving Inequalities Mathematical Olympiad methods and techniques for proving inequalities mathematical olympiad Mathematical olympiads often present challenging inequality problems that require a blend of creativity, insight, and rigorous reasoning. Mastering various methods and techniques for proving inequalities is essential for students aiming to excel in competitions like the International Mathematical Olympiad (IMO), National Olympiads, or other advanced mathematical contests. This article provides a comprehensive overview of the most effective strategies, approaches, and tools for tackling inequalities in mathematical olympiads, structured for clarity and depth. --- Understanding the Nature of Inequalities in Olympiads Before diving into specific methods, it’s crucial to understand the typical characteristics of inequalities encountered in olympiads: - They often involve symmetric or cyclic expressions. - Variables may be positive, real, or constrained within certain domains. - Inequalities can be algebraic, geometric, or combinatorial in nature. - The goal is usually to establish a minimal or maximal value, or to prove a certain inequality under given constraints. A solid comprehension of the problem’s structure guides the selection of appropriate techniques. --- Fundamental Techniques for Proving Inequalities Many inequalities can be approached through foundational methods, which serve as building blocks for more advanced strategies. 1. Direct Algebraic Manipulation This involves algebraic rewriting, expansion, factoring, or rationalizing expressions to reveal the inequality’s underlying structure. Key steps include: - Simplifying the inequality to a comparable form. - Clearing denominators carefully to avoid introducing extraneous solutions. - Factoring combined expressions to identify positive or negative components. - Using known algebraic identities (e.g., difference of squares, sum and difference formulas). 2. Rearrangement Inequality A powerful tool when dealing with sums and products of sequences: - States that for real sequences $a_1 \leq a_2 \leq \dots \leq a_n$ and $b_1 \leq b_2 \leq \dots \leq b_n$, the sum $\sum a_i b_{\pi(i)}$ is maximized when π is the identity permutation and 2 minimized when π reverses the order. - Useful for establishing bounds when variables are ordered or can be reordered. 3. Cauchy-Schwarz Inequality A fundamental inequality applicable in many

contexts: \[\left(\sum_{i=1}^n a_i b_i\right)^2 \leq \left(\sum_{i=1}^n a_i^2\right) \left(\sum_{i=1}^n b_i^2\right) \] - Often used to relate sums of products to sums of squares. - Particularly effective when variables appear symmetrically. 4. AM-GM and Other Classical Inequalities - Arithmetic Mean - Geometric Mean (AM-GM): \(\frac{a_1 + \dots + a_n}{n} \geq \sqrt[n]{a_1 a_2 \dots a_n}\) - Cauchy's Inequality, Hölder's Inequality, Jensen's Inequality: These provide bounds and relations for sums, integrals, or convex functions. - Useful for establishing inequalities involving symmetric sums or products. --- Advanced and Specialized Techniques Beyond the fundamental methods, olympiad problems often require more sophisticated approaches. 1. Substitution and Variable Transformation - Introducing new variables simplifies complex expressions. - Normalizations (e.g., setting sum of variables to 1) reduce the degrees of freedom. - Transformations can convert the inequality into a known form or a more manageable expression. 2. Homogenization - Makes inequalities scale-invariant by multiplying through by suitable powers of variables. - Facilitates the application of symmetric inequalities or known lemmas. 3. Symmetrization and Symmetrization Techniques - Exploits symmetry to reduce the problem to symmetric cases. - Techniques include replacing variables with their averages or considering symmetric sums. - For cyclic or symmetric inequalities, assuming variables are equal often simplifies the proof. 4. Induction and Extremal Principles - Using induction on the number of variables or parameters. - Applying extremal principles, such as assuming variables reach their maximum or minimum to test the inequality's bounds. 3 5. The Method of Mixing Variables - Replacing variables with averages or convex combinations. - Demonstrates that the extremum occurs when variables are equal, especially in symmetric inequalities. 6. Geometric Interpretations - Many inequalities have geometric analogs involving areas, lengths, or angles. - Using geometric transformations, similarity, or trigonometric identities can provide intuitive proofs. --- Strategies for Specific Types of Inequalities Different classes of inequalities often require tailored approaches. 1. Symmetric Inequalities - Leverage symmetry to assume variables are equal when seeking extrema. - Use known symmetric inequalities like Nesbitt's, Schur's, or Maclaurin's inequalities. 2. Cyclic Inequalities - Exploit cyclic symmetry by cyclically permuting variables. - Techniques include cyclic sums and the use of rearrangement inequalities. 3. Inequalities with Constraints - Use Lagrange multipliers or substitution to incorporate constraints. - Apply the method of fixing certain variables to analyze extremal cases. 4. Homogeneous Inequalities - Normalize variables to simplify. - Use scaling invariance to reduce the problem to a manageable case. --- Commonly Used Lemmas and Results Several lemmas frequently appear in inequality proofs: - Vasc's Lemma: For positive variables, the maximum of a sum occurs when variables are equal under certain conditions. - Muirhead's Inequality: Generalizes

symmetric sum inequalities based on majorization. - Karamata’s Inequality: Involves convex functions and majorization, useful when dealing with sums of convex or concave functions. - Chebyshev’s Inequality: Relates sums of products to sums of variables, useful with monotonic sequences. --- 4 Tips and Best Practices - Start with simple cases: Test the inequality with specific values to understand its behavior. - Identify symmetry: Symmetry often simplifies the proof or suggests equality cases. - Consider equality cases: Determine when the inequality becomes equality to guide the proof. - Use known inequalities: Recognize patterns that fit classical inequalities. - Transform variables: Simplify complex expressions through substitution or normalization. - Combine methods: Use a combination of algebraic, geometric, and analytical techniques for complex problems. - Practice regularly: Familiarity with a variety of inequalities and techniques enhances problem-solving speed and intuition. --- Conclusion Proving inequalities in mathematical olympiads requires a versatile toolkit of methods and techniques. From fundamental algebraic manipulations to advanced symmetrization and geometric insights, each problem may call for a unique combination of strategies. Developing a deep understanding of these methods, recognizing patterns, and practicing a wide array of inequalities will significantly enhance problem-solving skills and lead to greater success in mathematical competitions. Remember, the key is not only knowing these techniques but also cultivating intuition for their application in diverse contexts. QuestionAnswer What is the role of the Cauchy- Schwarz inequality in proving inequalities in mathematical olympiads? The Cauchy-Schwarz inequality is a fundamental tool that relates sums or integrals of products to the products of sums or integrals, enabling the transformation of complex expressions into more manageable forms and often leading to tight bounds in olympiad problems. How can the method of symmetry be used to prove inequalities in olympiad problems? The method of symmetry involves exploiting the symmetric or cyclic nature of variables to simplify the problem, often allowing one to reduce the number of variables or assume equality cases, which helps in establishing the inequality. What is the significance of Jensen's inequality in olympiad inequality proofs? Jensen's inequality relates convex or concave functions to averages, enabling the estimation of complex expressions and proving inequalities by transforming them into simpler, convexity-based comparisons. How does the method of introducing auxiliary variables assist in proving inequalities? Introducing auxiliary variables simplifies complex expressions, often linearizing non-linear terms or establishing bounds, which makes the inequality easier to analyze and prove. 5 Why is the rearrangement inequality useful in olympiad problem solving? Rearrangement inequality helps determine the maximal or minimal sum/product of pairs of sequences, allowing for the optimization and comparison of different arrangements to establish inequalities. How can the AM-GM inequality be applied in proving inequalities in olympiads? The AM-GM

inequality relates arithmetic and geometric means, providing lower or upper bounds for positive variables, which is often essential in establishing bounds and inequalities involving symmetric expressions. What is the technique of homogenization and how is it used in inequality proofs? Homogenization involves converting inequalities into homogeneous form, often by scaling variables, which simplifies the problem and allows the use of known homogeneous inequalities or inequalities involving degrees of variables. How do induction and extremal principle methods contribute to proving inequalities in olympiads? Mathematical induction can prove inequalities by establishing the base case and inductive step, while the extremal principle involves analyzing the maximum or minimum of the expression, often at boundary points or symmetric cases, to establish the inequality. What are the common pitfalls to avoid when applying methods to prove inequalities in olympiad problems? Common pitfalls include neglecting the domain restrictions, assuming equality cases without justification, misapplying inequalities outside their conditions, and overlooking the importance of symmetry or boundary cases, which can lead to incorrect conclusions. Methods and Techniques for Proving Inequalities in Mathematical Olympiads Proving inequalities is a central and often challenging aspect of mathematical olympiads. The ability to effectively demonstrate the truth of an inequality requires a deep understanding of various methods and techniques, as well as creative problem-solving skills. These techniques not only help in solving specific problems but also develop a mathematician’s intuition, enabling them to recognize underlying structures and patterns. In this article, we explore the most common and powerful methods used in proving inequalities in mathematical olympiad contexts, discussing their principles, applications, advantages, and limitations. Introduction to Inequality Proof Strategies Inequalities are ubiquitous in olympiad mathematics, often serving as stepping stones toward more complex results. The core challenge lies in transforming the given inequality into a form that is easier to analyze or compare. Over the years, mathematicians and olympiad participants have developed a repertoire of techniques, each suited for different types of problems. The key to mastery lies in understanding these methods deeply and Methods And Techniques For Proving Inequalities Mathematical Olympiad 6 knowing when to apply each one. Classical Methods for Proving Inequalities 1. Rearrangement Inequality The rearrangement inequality states that for two sequences sorted in the same order, the sum of the products of corresponding elements is maximized or minimized depending on the order. Principle: Given two sequences $a_1 \leq a_2 \leq \dots \leq a_n$ and $b_1 \leq b_2 \leq \dots \leq b_n$, then: $$ a_1b_1 + a_2b_2 + \dots + a_nb_n \leq \text{or} \geq a_1b_{\sigma(1)} + a_2b_{\sigma(2)} + \dots + a_nb_{\sigma(n)}, $$ where σ is a permutation. Features: - Effective for inequalities involving symmetric sums or products. - Helps establish extremal configurations. Pros: - Straightforward when

sequences are ordered. - Widely applicable in symmetric inequality problems. Cons: - Limited to problems with ordered variables. - Not directly applicable if the variables are not naturally ordered. 2. Cauchy-Schwarz Inequality One of the most fundamental inequalities, applicable in a wide variety of contexts. Statement: For real vectors $\mathbf{u}$ and $\mathbf{v}$, $$\left(\sum_{i=1}^n u_i v_i \right)^2 \leq \left(\sum_{i=1}^n u_i^2 \right)\left(\sum_{i=1}^n v_i^2 \right).$$ Features: - Can be used in algebraic, geometric, and combinatorial problems. Pros: - Versatile and powerful, often providing tight bounds. - Useful in converting sums of products into sums of squares. Cons: - Sometimes requires clever substitutions or additional steps. - Not always straightforward to see how to apply directly. 3. AM-GM Inequality (Arithmetic Mean - Geometric Mean) A fundamental inequality connecting the arithmetic mean and geometric mean. Statement: For positive real numbers $a_1, a_2, \dots, a_n$, $$\frac{a_1 + a_2 + \dots + a_n}{n} \geq \sqrt[n]{a_1 a_2 \dots a_n},$$ with equality when all a_i are equal. Features: - Often used to bound products or sums. - Can be extended to weighted means and other variants. Pros: - Simple to state and apply. - Effective in inequalities involving symmetric expressions. Cons: - Requires positivity of variables. - Not always sufficient; often used in conjunction with other methods. Advanced and Creative Techniques 4. Mixing Variables and Symmetrization This technique involves replacing variables with their averages or symmetrized forms to Methods And Techniques For Proving Inequalities Mathematical Olympiad 7 simplify the inequality. Principle: By replacing variables with their averages or convex combinations, one can often reduce the problem to a symmetric case, which is easier to analyze. Features: - Uses the symmetry of the problem to reduce complexity. - Often paired with Jensen’s inequality. Pros: - Simplifies multi-variable inequalities. - Can reveal extremal cases. Cons: - Not always applicable if the inequality lacks symmetry. - Requires insight into the structure of the problem. 5. Induction and Recursive Techniques Proving inequalities via induction involves establishing the base case and then assuming the inequality for n variables or elements to prove for $n+1$. Features: - Suitable for inequalities involving sequences or sums over n. Pros: - Systematic and rigorous. - Useful for inequalities that follow a recursive pattern. Cons: - Sometimes challenging to set up the induction step. - Not universally applicable, especially for inequalities involving multiple variables without a clear recursive structure. 6. Jensen’s Inequality and Convexity Jensen’s inequality relates the value of a convex (or concave) function applied to an average to the average of the function's values. Statement: If f is convex, then for any weights $a_i \geq 0$ with $\sum a_i = 1$, $$f\left(\sum a_i x_i\right) \leq \sum a_i f(x_i).$$ Features: - Powerful in problems involving convex functions, such as quadratic, exponential, or logarithmic functions. Pros: - Unifies many inequalities under a common framework. - Useful for bounding complicated expressions. Cons: - Requires

identifying the appropriate convex or concave function. - Sometimes nontrivial to apply directly. Specialized Techniques and Tricks 7. Substitution and Parameterization Replacing complicated expressions with parameters simplifies the inequality, often revealing its structure. Features: - Useful for inequalities involving symmetric sums or polynomial expressions. Pros: - Can reduce the problem to a single-variable inequality. - Facilitates the use of calculus or known bounds. Cons: - Requires careful choice of substitution. - May complicate the problem if not chosen wisely. 8. Convexity and Geometric Interpretations Many inequalities have geometric meanings, such as distances, angles, or areas, which can be exploited to provide proofs. Features: - Employs geometric intuition alongside algebraic techniques. Pros: - Visual insight can suggest the inequality’s validity. - Can lead to elegant, textbook-style proofs. Cons: - Not always applicable, especially in purely Methods And Techniques For Proving Inequalities Mathematical Olympiad 8 algebraic problems. - Requires geometric background. Combining Techniques and Creative Approaches Most olympiad inequalities are not solved by a single method but rather a combination. For example, one might start with the Cauchy-Schwarz inequality to relate sums, then apply AM-GM to handle symmetric parts, and finally use substitution to reduce the problem to a manageable form. Recognizing the structure of the problem and choosing the right combination is a skill developed through practice. Conclusion and Tips for Olympiad Success Proving inequalities in olympiad mathematics demands familiarity with a broad toolkit of methods, as well as the ability to adapt techniques contextually. Here are some concluding tips: - Master basic inequalities thoroughly: AM-GM, Cauchy-Schwarz, Jensen’s, and Rearrangement are foundational. - Practice problem recognition: Learn to identify the underlying structure that suggests a particular method. - Think geometrically when possible: Visual intuition can uncover elegant proofs. - Use symmetry and substitution: Simplify complex expressions to manageable forms. - Combine methods creatively: Often, a single approach is insufficient; combining techniques yields success. - Develop intuition: Regular practice with diverse problems sharpens your instinct for choosing the right method. In summary, the art of proving inequalities in olympiads hinges on understanding a variety of methods, knowing their strengths and limitations, and cultivating the creativity to apply them effectively. Mastery in this area significantly boosts problem- solving prowess and deepens mathematical understanding, making it an essential component of any aspiring olympiad mathematician’s skill set. inequality proofs, mathematical olympiad strategies, algebraic inequalities, geometric inequalities, Cauchy-Schwarz inequality, Jensen's inequality, AM-GM inequality, induction methods, classic inequality problems, problem-solving techniques

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this book is intended for the mathematical olympiad students who wish to prepare for the study of inequalities a topic now of frequent use at various levels of mathematical competitions in this volume we present both classic inequalities and the more useful inequalities for confronting and solving optimization problems an important part of this book deals with geometric inequalities and this fact makes a big difference with respect to most of the books that deal with this topic in the mathematical olympiad the book has been organized in four

chapters which have each of them a different character chapter 1 is dedicated to present basic inequalities most of them are numerical inequalities generally lacking any geometric meaning however where it is possible to provide a geometric interpretation we include it as we go along we emphasize the importance of some of these inequalities such as the inequality between the arithmetic mean and the geometric mean the cauchy schwarz inequality the rearrangementinequality the jensen inequality the muirhead theorem among others for all these besides giving the proof we present several examples that show how to use them in mathematical olympiad problems we also emphasize how the substitution strategy is used to deduce several inequalities

in china lots of excellent maths students take an active interest in various maths contests and the best six senior high school students will be selected to form the imo national team to compete in the international mathematical olympiad in the past ten years china s imo team has achieved outstanding results they won the first place almost every year the authors are coaches of china s imo national team whose students have won many gold medals many times in imo this book is part of the mathematical olympiad series which discusses several aspects related to maths contests such as algebra number theory combinatorics graph theory and geometry the book explains many basic techniques for proving inequalities such as direct comparison method of magnifying and reducing substitution method construction method and so on

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this book contains a unique collection of new inequalities that were specifically imagined by the author to challenge the boundaries of curiosity and imagination the inequalities are extremely beautiful and sharp and the book covers various topics from 3 and 4 variables inequalities symmetric and non symmetric inequalities to geometric inequalities many of the exercises are presented with detailed solutions covering a variety of must know old and new techniques in tackling olympiad problems the book contains also a variety of unsolved

exercises which were left to the reader as additional challenges most importantly the book deals with the daunting topic of asymmetric inequalities where most classical approaches fail the book has been organised in five chapters in the first one we presented a collection of classical algebraic and geometric inequalities such as cauchy schwarz cheybeshev s newton s bernoulli s euler s walker s inequalities among others these are the classical inequalities that any student should master if he is aiming for a medal at mathematical olympiad competitions the second and third chapters deal respectively with 3 and 4 variables inequalities covering both symmetric and asymmetric inequalities the fourth chapter is about geometric inequalities involving triangle sides medians altitudes internal bisectors areas perimeters orthic triangles angles circumradius inradius the last chapter contains detailed solutions to the proposed problems with more than one solution for some of the inequalities

a beautiful part in maths is inequality there are a lot of techniques and theorems related to inequality this is the main reason that inequality problems appear in most mathematics competitions therefore if you want to be a part of the competitions mastering in inequality is one thing that you must do challenging problems in inequalities is a little book about inequalities this book will provide you with the basics techniques and theorems in inequalities we will guide you through many interesting things in inequalities this book was written in three main parts the first part is about techniques and theorems in proving inequalities the second part is about problems and the last part of the book is about solutions in the first part of the book we try to dive readers into the basic inequalities we lead readers to understand many well known theorems such as qm am gm hm inequality cauchy schwarz inequality rearrangement inequality jensen s inequality schur s inequality and etc moreover in each chapter we give many examples in order to make to make sure that readers understand well about the theorem readers should keep in mind that learning maths is not about memorizing but it is all about understanding the more you understand about the lesson the more you perform really well in solving problems in the second part of the book we listed many challenging problems from around the world the aim of this part is to help readers to practice their understanding in the first part readers should try their best to solve the given problems before seeing the solutions it is good to figure the answers out by yourself however do not worry if you cannot solve them since the last part of the book is about solutions in this part we provide readers very detailed solutions to each problems all problems were solved step by step this part will help readers to evolve a lot we hope this book will help readers a lot in inequalities

this unique collection of new and classical problems provides full coverage of algebraic inequalities many of the exercises are presented with detailed author prepared solutions developing creativity and an arsenal of new approaches for solving mathematical problems algebraic inequalities can be considered a continuation of the book geometric inequalities methods of proving by the authors this book can serve teachers high school students and mathematical competitors it may also be used as supplemental reading providing readers with new and classical methods for proving algebraic inequalities

the focus of this book is algebraic inequalities not only is it the current mathematical olympiad hot topic it is also the basis of geometric inequalities in addition the book involves some analysis on inequality

this book discusses about the basic topics on inequalities and their applications these include the arithmetic mean geometric mean inequality cauchy schwarz inequality chebyshev inequality rearrangement inequality convex and concave functions and muirhead s theorem the book contains over 400 problems with their solutions a chapter on geometric inequalities is a special feature of this book most of these problems are from international mathematical olympiads and from many national mathematical olympiads the book is intended to help students who are preparing for various mathematical competitions it is also a good source book for graduate students who are consolidating their knowledge of inequalities and their applications

this book explores the theory and techniques involved in proving algebraic inequalities to expand the reader s mathematical toolkit the authors present problems from journals and contests from around the world inequalities are an essential topic in olympiad problem solving and 109 inequalities will serve as an instructive resource for students striving for success at national and international competitions inequalities are also of great theoretical interest and pave the way towards advanced topics such as analysis probability theory and measure theory most of all the authors hope that the reader finds inspiration in both the struggle and beauty of proving algebraic inequalities

more than a decade ago i published some notes on inequalities on the www with the same title as this book aimed for mathematical olympiad preparation i do not have specific data on how widespread it became however search results on the www publication data on researchgate and occasional emails from teachers and students gave me evidence that it had indeed spread worldwide while i was greatly overwhelmed and humbled that so many people across the world read my notes and presumably found them useful i also felt it necessary

to write a more detailed and improved version this culminated in the publication of this book while the main topics from the original notes have not changed this book does contain more details and explanations i therefore hope that it will be even more useful to everyone

mathematical olympiad competitions started in hungary at the end of the nineteenth century and are now held internationally they bring together able secondary school pupils who attempt to solve problems which develop their mathematical skills olympiad problems are unpredictable and have no obvious starting point and although they require only the skills learnt in ordinary school problems they can seem much harder the mathematical olympiad handbook introduces readers to these challenging problems and aims to convince them that olympiads are not just for a select minority the book contains problems from the first 32 british mathematical olympiad bmo papers 1965 96 and gives hints and outline solutions to each problem from 1975 onwards an overview is given of the basic mathematical skills needed and a list of books for further reading is provided working through the exercises provides a valuable source of extension and enrichment for all pupils and adults interested in mathematics

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this book compiles thoughtfully curated selection tests proposed to imo international mathematical olympiad teams across many countries offering a blend of original solutions and adaptations by the author this work is chronologically organized featuring problems from 1968 to 2024 and provides a unique insight into the evolution of this mathematical contest the work starts with a section containing key theories and examples serving as a quick reference guide the main inequalities and functional equations are covered along with topics on mathematical induction and polynomials this is followed by the problems themselves covering equations and systems of equations inequalities functional equations and inequalities mathematical induction and polynomials

a meticulously crafted index helps the reader navigate through the topics with ease references are provided for further reading and self study besides serving as an invaluable preparation tool for both aspiring students and those passionate about mathematics alike this book also complements selection tests in number theory for mathematical olympiads from the same author available at springer

olympiad mathematics is not a collection of techniques of solving mathematical problems but a system for advancing mathematical education this book is based on the lecture notes of the mathematical olympiad training courses conducted by the author in singapore its scope and depth not only covers and exceeds the usual syllabus but introduces a variety concepts and methods in modern mathematics in each lecture the concepts theories and methods are taken as the core the examples are served to explain and enrich their intension and to indicate their applications besides appropriate number of test questions is available for reader s practice and testing purpose their detailed solutions are also conveniently provided the examples are not very complicated so that readers can easily understand there are many real competition questions included which students can use to verify their abilities these test questions are from many countries e g china russia usa singapore etc in particular the reader can find many questions from china if he is interested in understanding mathematical olympiad in china this book serves as a useful textbook of mathematical olympiad courses or as a reference book for related teachers and researchers

olympiad mathematics is not a collection of techniques of solving mathematical problems but a system for advancing mathematical education this book is based on the lecture notes of the mathematical olympiad training courses conducted by the author in singapore its scope and depth not only covers and beyond the usual syllabus but introduces a variety of concepts and methods in modern mathematics as well in each lecture the concepts theories and methods are taken as the core the examples serve to explain and enrich their intentions and to indicate their applications besides appropriate number of test questions is available for the readers practice and testing purpose their detailed solutions are also conveniently provided the examples are not very complicated so readers can easily understand there are many real competition questions included which students can use to verify their abilities these test questions originate from many countries all over the world this book will serve as a useful textbook of mathematical olympiad courses a self study lecture notes for students or as a reference book for related teachers and researchers

the international mathematical olympiad imo is a competition for high school students china has taken part in

imo twenty times since 1985 and has won the top ranking for countries thirteen times with a multitude of golds for individual students the 6 students china sent every year were selected from 20 to 30 students among approximately 130 students who take part in the china mathematical competition during the winter months this volume comprises a collection of original problems with solutions that china used to train their olympiad team in the years from 2003 to 2006

this work is about inequalities which play an important role in mathematical olympiads it contains 175 solved problems in the form of exercises and in addition 310 solved problems the book also covers the theoretical background of the most important theorems and techniques required for solving inequalities it is written for all middle and high school students as well as for graduate and undergraduate students school teachers and trainers for mathematical competitions will also gain benefit from this book

for the curious reader looking to sharpen their arsenal of mathematical strategies on the olympiad level 113 geometric inequalities from the awesomemath summer program is a valuable addition this problem solving methodology prompts key ideas in other domains such as calculus or complex numbers as the solutions are usually nonstandard in a geometric sense nevertheless trying your hand at these types of inequalities consolidates your mathematical reasoning while exposing you to a broad range of problems all teeming with insightful inequality type solutions

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