Problem Set 1: Number Theory

Dakahlia Math Club

Week 1

Problems

1. The first two numbers that are both squares and triangles are 1 and 36. Find the next one and, if possible, the one after that. Can you figure out an efficient way to find triangular–square numbers? Do you think that there are infinitely many?

2. Try adding up the first few odd numbers and see if the numbers you get satisfy some sort of pattern. Once you find the pattern, express it as a formula. Give a geometric verification that your formula is correct.

3. The consecutive odd numbers 3, 5, and 7 are all primes. Are there infinitely many such "prime triplets"? That is, are there infinitely many prime numbers p such that $p + 2$ and $p + 4$ are also primes?

4. It is generally believed that infinitely many primes have the form $N^2 + 1$, although no one knows for sure.

   (a) Do you think that there are infinitely many primes of the form $N^2 - 1$?
   (b) Do you think that there are infinitely many primes of the form $N^2 - 2$?
   (c) How about of the form $N^2 - 3$? How about $N^2 - 4$?
   (d) Which values of a do you think give infinitely many primes of the form $N^2 - a$?

5. The following two lines indicate another way to derive the formula for the sum of the first n integers by rearranging the terms in the sum. Fill in the details.

$$1 + 2 + 3 + \cdots + n = (1 + n) + (2 + (n - 1)) + (3 + (n - 2)) + \cdots$$
$$= (1 + n) + (1 + n) + (1 + n) + \cdots .$$

How many copies of $n + 1$ are in the second line? You may need to consider the cases of odd n and even n separately. If that's not clear, first try writing it out explicitly for $n = 6$ and $n = 7$.

[Problems In Elementary Number Theory Problem Solving](#)

Nik Pachis

Problems In Elementary Number Theory Problem Solving:

    <u>Number Theory</u> Titu Andreescu,Dorin Andrica,2009-06-12 This introductory textbook takes a problem solving approach to number theory situating each concept within the framework of an example or a problem for solving Starting with the essentials the text covers divisibility unique factorization modular arithmetic and the Chinese Remainder Theorem Diophantine equations binomial coefficients Fermat and Mersenne primes and other special numbers and special sequences Included are sections on mathematical induction and the pigeonhole principle as well as a discussion of other number systems By emphasizing examples and applications the authors motivate and engage readers   <u>Problems of Number Theory in Mathematical Competitions</u> Hong-Bing Yu,2010 Number theory is an important research field of mathematics In mathematical competitions problems of elementary number theory occur frequently These problems use little knowledge and have many variations They are flexible and diverse In this book the author introduces some basic concepts and methods in elementary number theory via problems in mathematical competitions Readers are encouraged to try to solve the problems by themselves before they read the given solutions of examples Only in this way can they truly appreciate the tricks of problem solving   *Problem Solving in Mathematics* Thomas Butts,1973   <u>Equations and Inequalities</u> Jiri Herman,Radan Kucera,Jaromir Simsa,2012-10-05 A look at solving problems in three areas of classical elementary mathematics equations and systems of equations of various kinds algebraic inequalities and elementary number theory in particular divisibility and diophantine equations In each topic brief theoretical discussions are followed by carefully worked out examples of increasing difficulty and by exercises which range from routine to rather more challenging problems While it emphasizes some methods that are not usually covered in beginning university courses the book nevertheless teaches techniques and skills which are useful beyond the specific topics covered here With approximately 330 examples and 760 exercises   <u>Elementary Number Theory</u> Charles Vanden Eynden,2006-02-15 This practical and versatile text evolved from the author s years of teaching experience and the input of his students Vanden Eynden strives to alleviate the anxiety that many students experience when approaching any proof oriented area of mathematics including number theory His informal yet straightforward writing style explains the ideas behind the process of proof construction showing that mathematicians develop theorems and proofs from trial and error and evolutionary improvement not spontaneous insight Furthermore the book includes more computational problems than most other number theory texts to build students familiarity and confidence with the theory behind the material The author has devised the content organization and writing style so that information is accessible students can gain self confidence with respect to mathematics and the book can be used in a wide range of courses from those that emphasize history and type A problems to those that are proof oriented   **111 Problems in Algebra and Number Theory** Adrian Andreescu,Vinjai Vale,2016 Algebra plays a fundamental role not only in mathematics but also in various other scientific fields Without algebra there would be no uniform language to express concepts such as numbers properties Thus one must

be well versed in this domain in order to improve in other mathematical disciplines We cover algebra as its own branch of mathematics and discuss important techniques that are also applicable in many Olympiad problems Number theory too relies heavily on algebraic machinery Often times the solutions to number theory problems involve several steps Such a solution typically consists of solving smaller problems originating from a hypothesis and ending with a concrete statement that is directly equivalent to or implies the desired condition In this book we introduce a solid foundation in elementary number theory focusing mainly on the strategies which come up frequently in junior level Olympiad problems **Problems in Number Theory** Adam J Wick,2024-02-11 Welcome to the fascinating world of elementary number theory a branch of mathematics that deals with the properties and relationships of numbers especially the integers This book is designed to introduce readers to the beauty and utility of number theory through a collection of problems and their solutions Whether you are a student educator or enthusiast this book aims to enhance your understanding of number theory in an engaging and accessible manner Number theory is often considered the queen of mathematics due to its ancient origins and pure nature It is a field that has captivated mathematicians for centuries from the early discoveries of Euclid and Diophantus to the groundbreaking work of Fermat Euler Gauss and beyond The allure of number theory lies not only in its rich history but also in its applicability to modern day cryptography computer science and problem solving This book is structured to cater to a wide audience from beginners to those with some background in number theory The problems presented range from simple exercises that reinforce basic concepts to more challenging questions that stimulate deeper thinking and exploration Each problem is carefully selected and crafted to illustrate a particular aspect of number theory with solutions provided to guide the reader through the thought process and techniques involved The journey through this book begins with the fundamentals of divisibility primes and the Euclidean algorithm gradually progressing to more complex topics such as congruences and Diophantine equations Along the way readers will encounter famous theorems and conjectures that have shaped the field including the Fundamental Theorem of Arithmetic Fermat s Little Theorem and Wilson s theorem Our goal is not only to solve problems but also to cultivate a deeper appreciation for the elegance of mathematical concepts We encourage readers to actively engage with the material to explore beyond the solutions provided and to discover the joy of uncovering truths for themselves In preparing this book we have drawn upon a wealth of sources including classic texts and contemporary research to ensure a comprehensive and enriching experience We are grateful to the many mathematicians whose work has inspired and informed these pages and we hope to pass on a fraction of their passion for number theory to our readers Whether you are embarking on this journey out of curiosity academic interest or the pursuit of mathematical beauty we welcome you May this book serve as a valuable resource and companion as you explore the intriguing world of elementary number theory <u>Problem Solving in School Mathematics</u> ,1980 *Exemplary Practices for Secondary Math Teachers* Alfred S. Posamentier,Daniel Jaye,2007-03-15 Every year new secondary mathematics teachers take up positions in middle

and high schools The luckiest novices receive assistance from a coach or mentor a master mathematics teacher who makes constructive comments models effective approaches and illuminates other practical aspects of teaching secondary math But many new teachers don t have this advantage and must further their development on their own If you are one of these teachers this is the book you need In these pages veteran mathematics educators Alfred S Posamentier Daniel Jaye and Stephen Krulik present a treasure chest of ideas to guide new secondary math teachers through the challenging first few months and also provide more experienced teachers with interesting alternatives to familiar methods The topics covered include The most effective instructional practices The best uses of the textbook Designing successful lessons Creating homework that promotes learning Incorporating challenge Teaching reasoning and problem solving Strategies for assessment and grading Specific innovative ideas for teaching key concepts Options for extracurricular activities Long term professional enrichment and growth It s during the first few years of a teacher s experience that he or she develops the habits methods procedures and techniques that tend to define a career Exemplary Practices for Secondary Math Teachers provides both a foundation for excellence and a touchstone for years to come Note This product listing is for the Adobe Acrobat PDF version of the book   250 Problems in Elementary Number Theory Waclaw Sierpinski,1970   **Steps into Analytic Number Theory** Paul Pollack,Akash Singha Roy,2021-02-08 This problem book gathers together 15 problem sets on analytic number theory that can be profitably approached by anyone from advanced high school students to those pursuing graduate studies It emerged from a 5 week course taught by the first author as part of the 2019 Ross Asia Mathematics Program held from July 7 to August 9 in Zhenjiang China While it is recommended that the reader has a solid background in mathematical problem solving as from training for mathematical contests no possession of advanced subject matter knowledge is assumed Most of the solutions require nothing more than elementary number theory and a good grasp of calculus Problems touch at key topics like the value distribution of arithmetic functions the distribution of prime numbers the distribution of squares and nonsquares modulo a prime number Dirichlet s theorem on primes in arithmetic progressions and more This book is suitable for any student with a special interest in developing problem solving skills in analytic number theory It will be an invaluable aid to lecturers and students as a supplementary text for introductory Analytic Number Theory courses at both the undergraduate and graduate level   CRC Concise Encyclopedia of Mathematics Eric W. Weisstein,2002-12-12 Upon publication the first edition of the CRCConcise Encyclopedia of Mathematics received overwhelming accolades for its unparalleled scope readability and utility It soon took its place among the top selling books in the history of Chapman Hall CRC and its popularity continues unabated Yet also unabated has been the d   **Problems and Proofs in Numbers and Algebra** Richard S. Millman,Peter J. Shiue,Eric Brendan Kahn,2015-02-09 Focusing on an approach of solving rigorous problems and learning how to prove this volume is concentrated on two specific content themes elementary number theory and algebraic polynomials The benefit to readers who are moving from calculus to more abstract

mathematics is to acquire the ability to understand proofs through use of the book and the multitude of proofs and problems that will be covered throughout This book is meant to be a transitional precursor to more complex topics in analysis advanced number theory and abstract algebra To achieve the goal of conceptual understanding a large number of problems and examples will be interspersed through every chapter The problems are always presented in a multi step and often very challenging requiring the reader to think about proofs counter examples and conjectures Beyond the undergraduate mathematics student audience the text can also offer a rigorous treatment of mathematics content numbers and algebra for high achieving high school students Furthermore prospective teachers will add to the breadth of the audience as math education majors will understand more thoroughly methods of proof and will add to the depth of their mathematical knowledge In the past PNA has been taught in a problem solving in middle school course twice to a quite advanced high school students course three semesters and three times as a secondary resource for a course for future high school teachers PNA is suitable for secondary math teachers who look for material to encourage and motivate more high achieving students

Elementary Number Theory James S. Kraft,Lawrence C. Washington,2014-11-24 Elementary Number Theory takes an accessible approach to teaching students about the role of number theory in pure mathematics and its important applications to cryptography and other areas The first chapter of the book explains how to do proofs and includes a brief discussion of lemmas propositions theorems and corollaries The core of the tex **Research in Collegiate Mathematics Education IV** Ed Dubinsky,2000 This fourth volume of Research in Collegiate Mathematics Education RCME IV reflects the themes of student learning and calculus Included are overviews of calculus reform in France and in the U S and large scale and small scale longitudinal comparisons of students enrolled in first year reform courses and in traditional courses The work continues with detailed studies relating students understanding of calculus and associated topics Direct focus is then placed on instruction and student comprehension of courses other than calculus namely abstract algebra and number theory The volume concludes with a study of a concept that overlaps the areas of focus quantifiers The book clearly reflects the trend towards a growing community of researchers who systematically gather and distill data regarding collegiate mathematics teaching and learning This series is published in cooperation with the Mathematical Association of America **The Induction Book** Steven H. Weintraub,2017-05-03 Every mathematician and student of mathematics needs a familiarity with mathematical induction This volume provides advanced undergraduates and graduate students with an introduction and a thorough exposure to these proof techniques 2017 edition *Notes and Problems in Number Theory (Volume II)* Taha Sochi,2024-05-23 This is the second volume of my book Notes and Problems in Number Theory We focus in this volume on the type of problems that develop the basic and most essential skills which are required for dealing with number theory problems We introduced some new topics in the first chapter i e Introduction while the remaining chapters are largely dedicated to solved problems from the main topics of elementary number theory which are introduced in V1 or in the

Introduction chapter of the present volume We also introduced the subject of cryptography and computing in number theory in the last two chapters So in brief the materials in this volume are largely a mix of applications to the materials of V1 and some theoretical background of new topics as well as applications to the new topics As in my previous books my topmost priority in the structure and presentation is clarity and graduality so that the readers have the best chance of understanding the content with minimum effort and with maximum enjoyment The book can be used as a text or as a reference for an introductory course on number theory and may also be used for general reading in mathematics especially by those who have the hobby of problem solving The book may also be adopted as a source of pedagogical materials which can supplement for instance tutorial sessions e g in undergraduate courses on mathematics or computing or cryptography or related subjects

Number Theory - Structures, Examples and Problems Nik Pachis,2016-04-01 Number theory branch of mathematics concerned with properties of the positive integers Sometimes called higher arithmetic it is among the oldest and most natural of mathematical pursuits Number theory has always fascinated amateurs as well as professional mathematicians In contrast to other branches of mathematics many of the problems and theorems of number theory can be understood by laypersons although solutions to the problems and proofs of the theorems often require a sophisticated mathematical background Number theory is a vast and fascinating field of mathematics sometimes called higher arithmetic consisting of the study of the properties of whole numbers Primes and prime factorisation are especially important in number theory as are a number of functions such as the divisor function Riemann zeta function and totient function Number theory is an ongoing rich area of mathematical exploration with connections and applications to other fields from representation theory to physics cryptography and more While the forefront of number theory is replete with sophisticated and famous open problems at its foundation are basic elementary ideas that can stimulate and challenge beginning students This book Number Theory Structures Examples and Problems focuses on a problem solving approach to the subject   *Mathematical Programming and the Numerical Solution of Linear Equations* Bert W. Rust,Walter R. Burrus,1972   **Farey Sequences** Andrey O. Matveev,2017-11-07 As a first comprehensive overview on Farey sequences and subsequences this monograph is intended as a reference for anyone looking for specific material or formulas related to the subject Duality of subsequences and maps between them are discussed and explicit proofs are shown in detail From the Content Basic structural and enumerative properties of Farey sequences Collective decision making Committee methods in pattern recognition Farey duality Farey sequence Fundamental Farey subsequences Monotone bijections between Farey subsequences

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