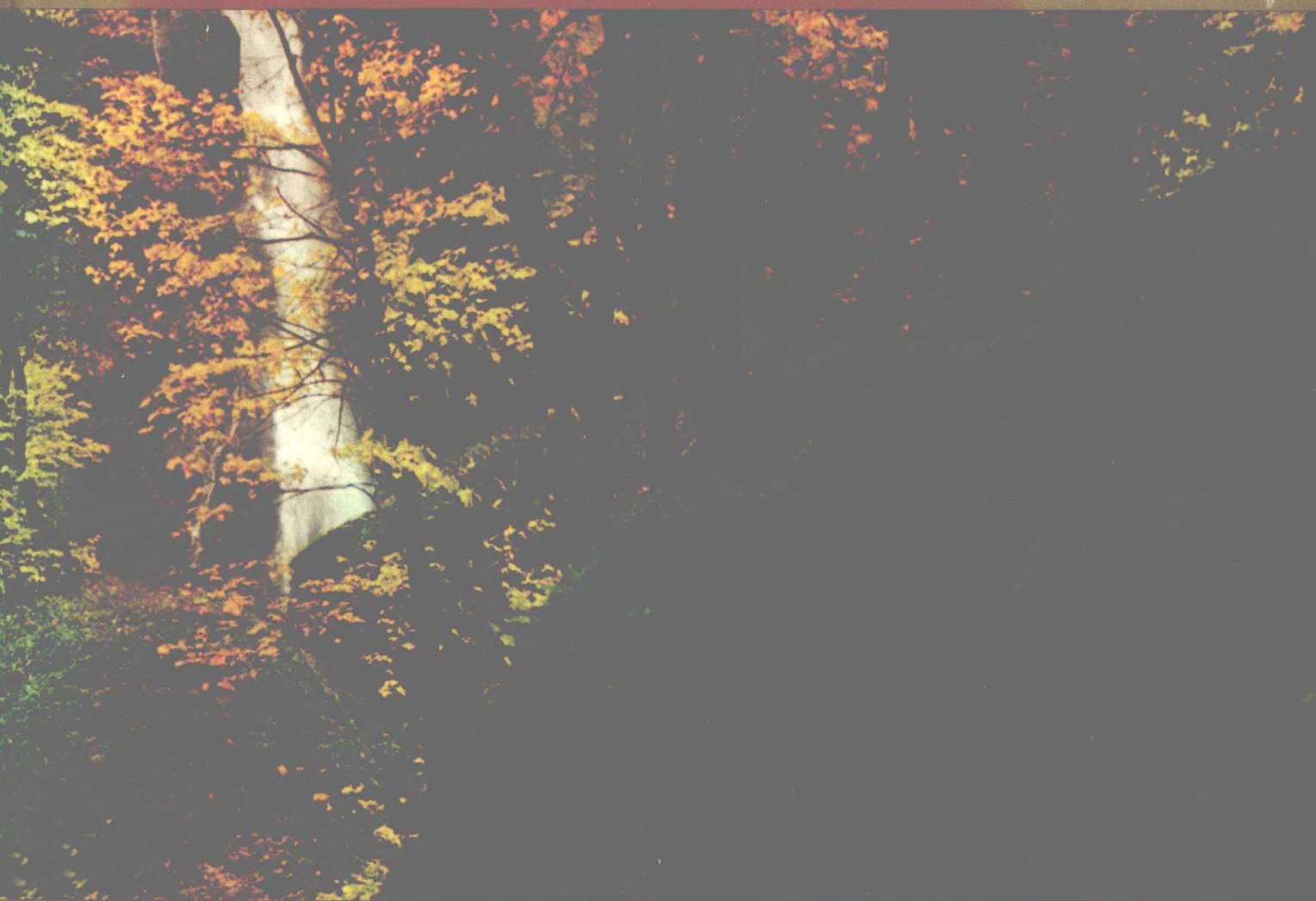
TEACHER'S EDITION

James Streeter
Donald Hutchison
Louis Hoelzle

Beginning Algebra



Third Edition

Form A

Teacher's Edition for Beginning Algebra, Form A

Third Edition

James Streeter
Late Professor of Mathematics
Clackamas Community College

Donald Hutchison
Clackamas Community College

Louis Hoelzle
Bucks County Community College

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Teacher's Edition for Beginning Algebra, Form A

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ABOUT THE AUTHORS

While a graduate student at the University of Washington, James Streeter paid for his education as a math tutor. It was here that he began to formulate the ideas that would eventually become this package. Upon graduation he taught for two years at Centralia Community College. In 1968 he moved on to Clackamas Community College to become their first mathematics chair.

At the community college, Jim recognized that he faced a very different population than the one for whom he had tutored at UW. Jim was convinced that, in order to reach the maximum number of these students, he would have to utilize every medium available to him. Jim opened a math lab that included CAI, original slides and tapes (which were eventually published by Harper and Row) and original worksheets and text materials. With the assistance of the people at McGraw-Hill, that package has been refined to include media and supplements that did not even exist when this project began.

Donald Hutchison spent his first 10 years of teaching working with disadvantaged students. He taught in an intercity elementary school and an intercity high school. He also worked for two years at Wassaic State School in New York and two years at the Portland Habilitation Center. He worked with both physically and mentally disadvantaged students in these two settings.

In 1982 he was hired by Jim Streeter to teach at Clackamas Community College. It was here that he discovered the two things that, along with his family, serve as a focus for his life. Jim introduced him to the joy of writing (with the first edition of *Beginning Algebra*) and Jack Scrivener converted him to a born-again environmentalist.

Don is also active in several professional organizations. He is a member of the ACM committee that has undertaken the writing of computer curriculum for the two-year college. Since 1990 he has chaired the Technology in Mathematics Education committee for AMATYC.

In 1989 Don became Chair of the Mathematics department at Clackamas Community College.

Louis Hoelzle has been teaching at Bucks County Community College for 23 years. He has taught the entire range of courses from Arithmetic to Calculus. This gives him the perspective of the current and future needs of developmental students.

Over the past 30 years Lou has also taught Physics courses at four year colleges. This gives him the perspective of the practical applications of mathematics.

In addition, Lou has done extensive reviewing of manuscripts and writing of several solutions manuals for major texts. In these he has focused on writing for the student.

Lou is also active in professional organizations and has served on the Placement and Assessment Committee for AMATYC since 1989.

In 1989, Lou became Chair of the Mathematics Department at Bucks County Community College.

A teacher affects eternity; he can never tell where his influence stops.

—Henry Brooks Adams 1838–1918

This series is dedicated to the memory of James Arthur Streeter, an artisan with words, a genius with numbers, and a virtuoso with pictures from 1940 until 1989.

There is a German proverb that has been translated, ''More is to be got from one teacher than from two books.'' This reflects the essence of what I have learned about writing from Jim Streeter. Jim was always a teacher who wrote, and never a writer who taught. Jim was a teacher in the classroom, in his office, during meetings, and behind his word processor. From Jim's perspective, it seemed that life's single challenge was to find the components that, when properly assembled, would reveal the concept that he wanted to explain. One night Jim and I went out to celebrate the completion of a manuscript. I taught him a dart game called ''301.'' He was fascinated. I doubt that he ever played again, but he used the game in the classroom and in his writing. He found it an entertaining medium for teaching subtraction, multiplication, and critical thinking skills (e.g., ''If you need 15 points, and you must finish with a double score, how many different ways can you win with two darts?'')

Jim did not believe in platitudes, but he did convince me that ''writing makes one a better teacher and teaching makes one a better writer.'' Because I knew Jim, I have become a better writer, a better teacher, and a better person.

Donald Hutchison

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PREFACE

When we study mathematics, we study questions at three levels:

What is mathematics?

What can we do with mathematics?

How do we do it?

The first question is reserved for higher-level mathematics and philosophy courses (where one can pursue the debate about whether mathematics is a product of human endeavor or rather the discovery of a natural system).

The remaining two questions are at the core of every lecture in every mathematics class we teach. The purpose of this textbook is to help the student discover answers to the last two questions.

The focus in teaching this course is to make our students better problem-solvers. Our emphasis as writers is to communicate this to our audience. The language must be at the appropriate level. The topics must be broad enough to include all of the concepts that the student will need both in future mathematics classes and future employment. And the problems must relate enough to student experience to motivate the topic.

One of our goals has been to create a set of applications that would be more relevant to the student. A greater part of our goal was reached by incorporating a theme.

The *environmental theme* is an important new element of this edition of *Beginning Algebra.* The reason for this focus is twofold: our own, and the mathematics community's concern for the state of the earth and our realization that most students share this concern. As a result, students become more interested in learning how to use mathematics when they are interested in what kinds of problems can be solved.

Each chapter of this text opens with an *environmental essay.* These essays were written by Jack Scrivener, who teaches both beginning algebra and environmental science at Clackamas Community College in Oregon City, Oregon. The essays have been written specifically for these students at this level. Professor Scrivener's ten years of teaching these two courses makes him uniquely qualified to reach this audience.

Within each chapter are exercises that specifically relate to the environmental essay for that chapter. These were also written by Professor Scrivener. They are easily identified by the tree logo that appears over the exercise number. Our goal was to produce a set of noncontrived problems that students could solve with the skills they have just learned. We are very pleased with the results. Occasionally one of the problems will be a stretch for all of the students, but

it's a reachable stretch. It is also a stretch that motivated students are more likely to attempt.

Several other features new to the third edition of this text are designed to better teach students how to do the mathematics. Among those features, we have

A *worktext format* printed on *recycled paper* that incorporates *four colors* to guide students through critical steps and increase clarity in graphs.

Also new to this edition are the *expression screens.* In teaching this course (and intermediate algebra as well) we have discovered that many students are unable to identify whether they are working on an expression or an equation. When this is the case, they do not know what form the answer should take. We have tried to address this problem in two ways. First, we have expanded the discussion about the difference, and we have included several exercises in which the student is to do no more than identify whether each item is an expression or an equation. Then, to avoid confusion, we have *screened the expression* in any example in which the student is asked to simplify. By screening the expression, it is clear to the student just what it is they are simplifying.

Think about These are new exercises that require the student to extend or generalize from the skills just learned. These exercises promote and utilize critical thinking skills.

This new edition also includes the *Retain Your Skills* exercise sets. These twenty-question review quizzes appear at the end of chapters 5, 7, and 9. They remind the student of skills learned and encourage regular cumulative review of the material.

Other features retained from the second edition include

Check Yourself These exercises accompany the text examples and are designed to involve the student actively in the learning process. Answers are provided at the end of the section for immediate feedback.

Build Your Skills Exercises that allow the student to practice and master the skills of the section.

Skillscan Draws problems from previous sections of the text. Designed to aid the student in the process of reviewing concepts that will be applied to the following section.

Chapter Summaries and Summary Exercises These sections give the student an opportunity to practice and review at the end of each chapter. Answers are provided with section references to aid in the process of review.

Self-Tests Each chapter concludes with a self-test to give students guidance in preparing for in-class tests. Answers are provided at the back of the book.

Cumulative Test These are designed to give the student further opportunity for building skills which should be especially useful for students preparing for mid-term and final exams.

We continue to encourage the participation of students in the learning process by directing our attention to readability and student involvement. Each topic is developed in a straightforward fashion with numerous examples to clarify the subject being developed. All important definitions, rules, and algorithms are enhanced with color for easy identification and reference.

Pattern recognition and problem-solving strategies are two themes retained in this edition. One way in which we encourage pattern recognition is in the matching exercises incorporated into various exercise sets. For instance, in Chapter 10 (''Quadratic Equations'') we include linear graphs in the exercise set to encourage more discriminant thinking on the part of the students.

All the features are designed to encourage, facilitate, and motivate problem solving among the students. This is not just the nature of this text, it is the primary basis for the inclusion of mathematics in virtually every curriculum.

Supplements

There are a number of supplements available for both the student and instructor. The *Teacher's Edition* includes answers to all exercises and tests. These answers are printed in a second color for easier use by the instructor. The *Instructor's Solutions Manual* contains worked-out solutions and answers to all of the exercises in the text. The *Student's Solutions Manual* contains worked-out solutions to the odd-numbered exercises in the text. *The Instructor's Resource Manual* contains multiple-choice placement tests for three levels, a diagnostic pretest for each chapter, three forms of multiple-choice and open-ended chapter tests, two forms of multiple-choice and open-ended cumulative tests, two forms of multiple-choice and open-ended final tests, an answer section, and appendixes. The *video series* provides the student with additional instructional and visual support of the lessons. *The Professor's Assistant* is a computerized test generator that allows the instructor to create tests using algorithmically generated test questions and those from a standard testbank. This testing system enables the instructor to choose questions either manually or randomly by section, question type, difficulty level, and other criteria. This system is available for IBM, IBM compatible, and Macintosh computers. The *Print Test Bank* is a printed and bound copy of the questions found in the standard testbank. The *Interactive Tutorial Software* is a self-paced interactive tutorial specifically linked to the text. This tutorial reinforces selected topics and provides unlimited opportunities to review concepts and to practice problem solving. It requires virtually *no* computer training on the part of the student and is available for IBM, IBM compatible, and Macintosh computers. The *Calculator Enhancement Manual* presents an integrated approach that utilizes calculator-based graphing to enhance understanding and development. It includes calculator exercises and examples as well as appendices on how to use the most popular calculators. For further information about these supplements, please contact your local college division sales representative.

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As mentioned, we had many contributions to the development of this edition and the previous edition. Thanks to

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Donald Hutchison

Louis Hoelzle

TO THE STUDENT

You are about to begin a course in algebra. We have made every attempt to provide a text that will help you understand what algebra is about and how to effectively use it. We have made no assumptions about your previous experience with algebra. Your rate of progress through the course will depend both upon the amount of time and effort that you give to the course and to your previous background in mathematics. There are some specific features in this textbook that will aid you in your studies. Here are some suggestions about how to use those features.

Keep in mind that a review of *all* of the chapter material will further enhance your ability to grasp later topics and to move more effectively through the following chapters.

1. If you are in a lecture class, make sure that you take the time to read the appropriate text section *before* your instructor's lecture on the subject. Then take careful notes on the examples that your instructor presents during class.
2. After class, work through similar examples in the text, making sure that you understand each of the steps shown. Examples are followed by *Check Yourself* exercises. Algebra is best learned by being involved in the process and that is the purpose of these exercises. Always have a pencil and paper at hand and work out the problems that are presented and check your results immediately. If you have difficulty, go back and carefully review the previous exercises. Make sure that you understand what you are doing and why. The best test of whether you do understand a concept lies in your ability to explain that concept to one of your fellow students. Try working together.
3. At the end of each chapter section you will find a set of exercises. Work these carefully in order to check your progress on the section you have just finished. You will find the solutions for the odd-numbered exercises following the problem set. If you have had difficulties with any of the exercises, review the appropriate parts of the chapter section. If your questions are not completely cleared up, by all means do not become discouraged. Ask your instructor or an available tutor for further assistance. A word of caution: Work the exercises on a regular (preferably daily) basis. Again, learning algebra requires becoming involved. As is the case with learning any skill, the main ingredient is practice.
4. When you have completed a chapter, review by using the *Chapter Summary.* You will find all the important terms and definitions in this section, along with examples illustrating all the techniques that have been developed in the chapter. Following the summary are *Summary Exercises* for further practice. The exercises are keyed to chapter sections, so you will know where to turn if you are still having problems.

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5. When done with the *Summary Exercises,* try the *Self-Test* that appears at the end of each chapter. This will give you an actual practice test to work as you review for in-class testing. Again, answers with section references are provided.
6. Finally, an important element of success in studying algebra is the process of regular review. We have provided a series of *Cumulative Tests* throughout the textbook (they are located after Chapters 3, 6, 8, and 10) and *Retain Your Skills* exercises (Chapters 5, 7, and 9). These will help you review not only the concepts of the chapter that you have just completed, but those of previous chapters. Use these in preparation for any midterm or final examinations. If it appears that you have forgotten some concepts that are being tested, don't worry. Go back and review the sections where the idea was initially explained, or the appropriate chapter summary. That is the purpose of these cumulative tests.

We hope that you will find our suggestions helpful as you work through this material, and we wish you the best of luck in the course.

Donald Hutchison
Louis Hoelzle

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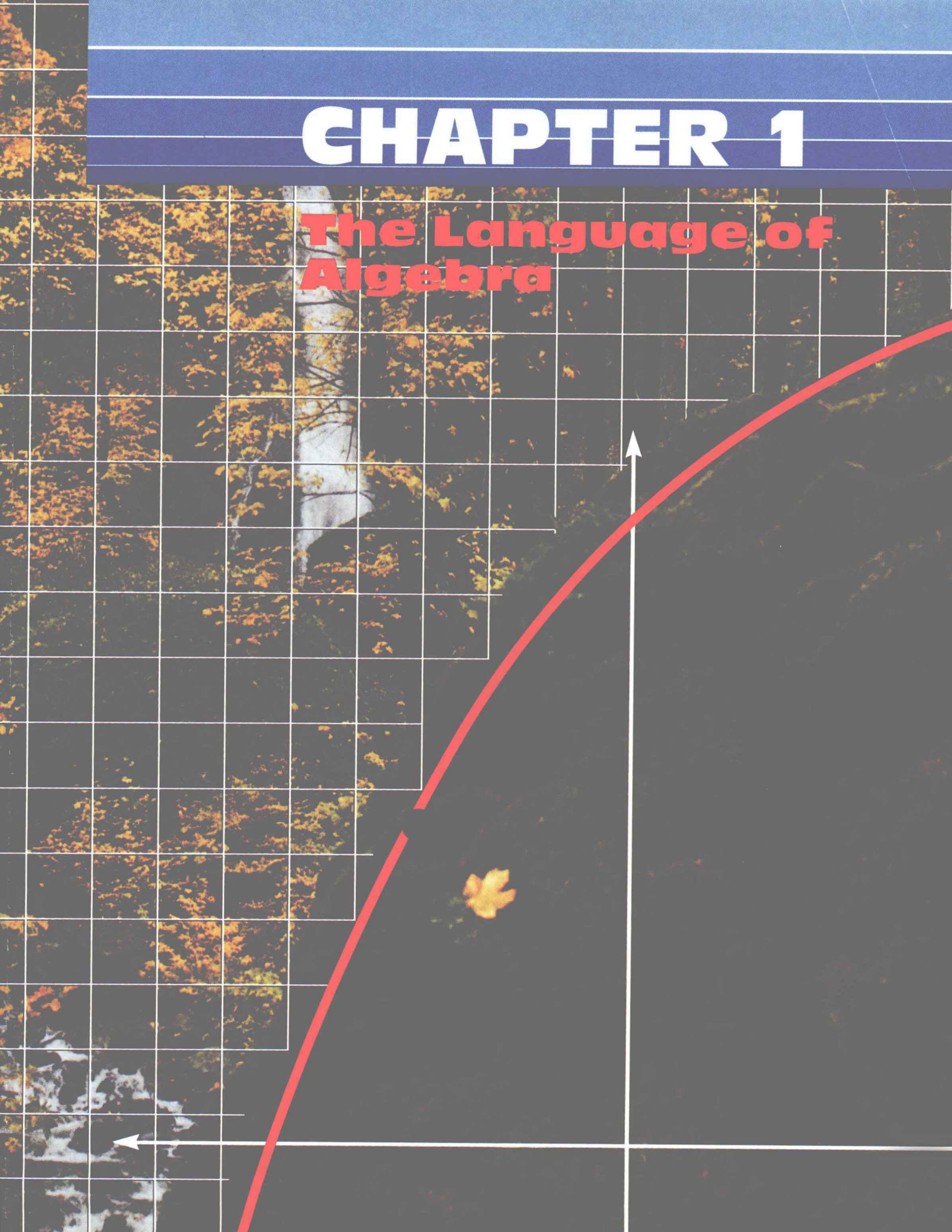
CHAPTER 1

The Language of Algebra



The ENVIRONMENT

Introduction to Environmental Problems

The earth's population has more than doubled in the last 40 years. It is highly likely that it will double again in the next 40 years. Almost 61,000 square kilometers of desert are formed each year. We are destroying 202,000 square kilometers of tropical forest every year. One-third of the world's cropland is losing soil faster than it is being formed. One-half of the world's wetlands have been lost to development or pollution. Thousands of lakes in the northern hemisphere contain no fish because of their high acid content. Tons of waste wash up onto the world's beaches daily.

The environment is no longer the concern of only a few scientists and environmental activists. Environmental pollution and disruption has become front-page news for the citizens of the planet. Understanding how we are affected by these problems is important to our individual lives. Knowing how individual people cause environmental problems helps us make decisions about our personal actions and lifestyles.

Each chapter of this text will begin with an environmental essay. These essays will show how people are causing rapid changes on this planet. They will also discuss how these changes are affecting the people of the planet. Many people are not aware that their behavior can cause problems for other living things. These essays will show a connection between the actions of individuals and the problems that affect all of us.

Exercises within the problem sets will relate to the theme of that chapter. These exercises will provide practice with the mathematics necessary to grasp the importance of the ideas discussed in each essay. Although the algebra has occasionally been simplified, it is never contrived. These are real problems facing all of us.

Environmental problems are not confined to one part of the globe or to one aspect of the environment. The air, water, land, plants, animals, and humans have all been affected by these problems. Problems such as acid rain, ozone depletion, and overpopulation make the news regularly. We also hear about world hunger, extinction of plants and animals, and global warming. These are not local problems. They affect the entire planet.

When we first look at the wide range and size of these problems, we can become overwhelmed. These essays will show that individual action can both avoid creating future problems and help cure some of those that already exist. The exercises will show that basic algebra can help us analyze and solve these problems.

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