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## Solving Problems From the Pitch

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Book layout by A.R. Harter
Editor: Naomi Sweo

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Printed in the United States of America.

ISBN-13: 978-1-59647-428-4

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# Introduction for Parents and Teachers

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## Activities

The first section poses a variety of problem situations all based on the numbers of soccer. This section includes problems centered on the soccer pitch, famous players, awards, and league play around the world. The problems themselves are varied, including:

- **Activities using different sets of numerals.** By the time students are finished with the eighth grade, they should be proficient with problem solving involving numeral types, such as whole number computation, fraction computation, decimal computation, and percent computation.

- One way to classify problem-solving activities includes two general categories of problems:

  1. **Routine Problems:** These problems ask students to apply a computational procedure to real-life situations.

  2. **Non-routine Problems:** These problems require the use of *heuristics,* in which the learner creates or invents a new series of steps to solve a problem. With these, the student is not just using a computational procedure. This process involves advanced-level thinking skills, and is preferred by math educators.

  It is not appropriate to give students only problems that review the computational operations they have learned. Problems should also ask students to examine data, ask questions, and find or create ways for solving real problems.

### Routine Problems

Students have been asked to solve routine problems for years. These problems ask students to apply learned mathematical processes in order to answer questions. We will use two types of routine problems here:

1. **Algorithmic Problems:** These are traditional math story problems; they require that a student read a problem, figure out the computational procedure required, and then apply that computational process to solve the problem. For example:

   Bobby scored 16 goals in the last soccer season. This year he wants to score 25 goals. How many more goals does he wish to score during the upcoming year than he scored last year?

2. **Multi-step Problems:** These are a special type of routine problem that requires students to use two or more computational operations to obtain the answer. For example:

   Last year the Galaxy team played 12 games, winning ¾ of them. This year, during the entire season, they won only 5 games. How many games did they win over the two seasons combined?

Routine problems can be created with any type of number and any type of computational operation. Students should know that computational processes—from adding whole numbers to dividing decimal numerals—can be used to solve real-world problems. As teachers and parents, we cannot stop after assigning only routine problems.

### Non-Routine Problems

In recent years math educators have focused additional energy on non-routine problems—those problems that challenge the learner in new, unique ways. We have attempted to include various kinds of non-routine problems in this book. They include:



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1. **Projects:** These projects, which are not simple story problems, involve a "process." They are open-ended, in that different students may seek different data and obtain different answers. The process is more important than the product; the process stresses such things as solving multiple computational situations, often using multiple problems to obtain the answer, comparing differences in answers, and discussing all considerations to see if everyone agrees. For example:

   > How can we create and understand a table showing scoring differentials for each team in the league?

   This task depends on several variables. Not every table will be the same. Each will have different figures that must be explored. These problems are important for children to solve in order to learn that not all problems have simple answers, and that not all problems have just one answer.

2. **Challenge Problems:** Problems of this type ask the learner to do more than just solve a problem using math procedures. They require the use of communication skills—to explain an answer—or of heuristics, a big word meaning the problem solver must invent and/or create the steps or procedures that will lead to the answer. This act of invention is important, as it is the true test of problem-solving ability. The child cannot stop learning mathematics until he or she is capable of inventing solutions to problems never seen before. For example:

   > Create a chart showing the differential between goals allowed and goals scored, and whether scoring more goals or limiting the opposition's goals has a greater impact on your team's final league standing.

Professional scientists, engineers, and mathematicians all work to create new ideas and solve new problems. We do not ask these professionals to rehash old ideas to solve old problems. And it is not only those working in the "math professions" who must invent solutions to solve problems. The carpenter, plumber, clerical worker, or housewife all invent solutions to problems every day. All of us are problem solvers, and many of our problems involve numbers and math. The children in one's life should be encouraged to become problem-solvers—it is a skill they will all need!

## Math Projects

Finally, because this book is meant to capture the interest of students by combining mathematics and soccer, we have suggested different projects for students. These are not technically math problems; they are projects students can undertake that require the use of math while offering them the opportunity to examine the history of soccer. These projects will hopefully make both math and soccer some of a child's special interests.

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# Introduction for Students

Soccer is the world's game—and it is played in almost every nation in the world. While people of the United States know this game as soccer, the rest of the world calls it *football*.

This book is about that game, whatever you call it, but we'll call it soccer here for simplicity's sake. Here you will find a great deal of interesting material about soccer—the professional teams and players from around the world, the Olympic contests and the international soccer championships, college men's and women's soccer, and even youth soccer games. But in this book you will also find math. These pages will ask you to solve math problems about soccer and its statistics, its stories, its interesting situations, and its championship seasons.

For example, here you can see how playing fields may differ in size, and you will figure out how difficult it is to defend a penalty kick. You will see how offensive statistics are important—both for the individual players and their teams. You will find problems about soccer statistics to figure examples on how numbers impact the game and its final scores and standing. And you will figure them out for yourself. But you will enjoy the book much more if you tackle the various projects that involve keeping track of soccer statistics for a game or a season, in any of the world's many soccer leagues and championships. Collect all kinds of statistics on your favorite player, then see if you can figure out how he or she helps the team. Or, if you are playing soccer, keep track of your own statistics and rate yourself!

The book also contains a number of facts about national and international soccer events. For example, which female player holds the U.S. career scoring record in international games and championships? Or, which English teams are consistently good and which teams face "relegation"? (That is an interesting concept, and you will find many resources that explain it.) All this information is presented in fun-to-solve math problems.

So, this book is about both soccer and math. It is meant to be fun. We hope you enjoy playing the popular sport of soccer, we hope you enjoy solving problems about soccer, and most of all, we hope that you begin to collect your own statistics about soccer.

Enjoy!

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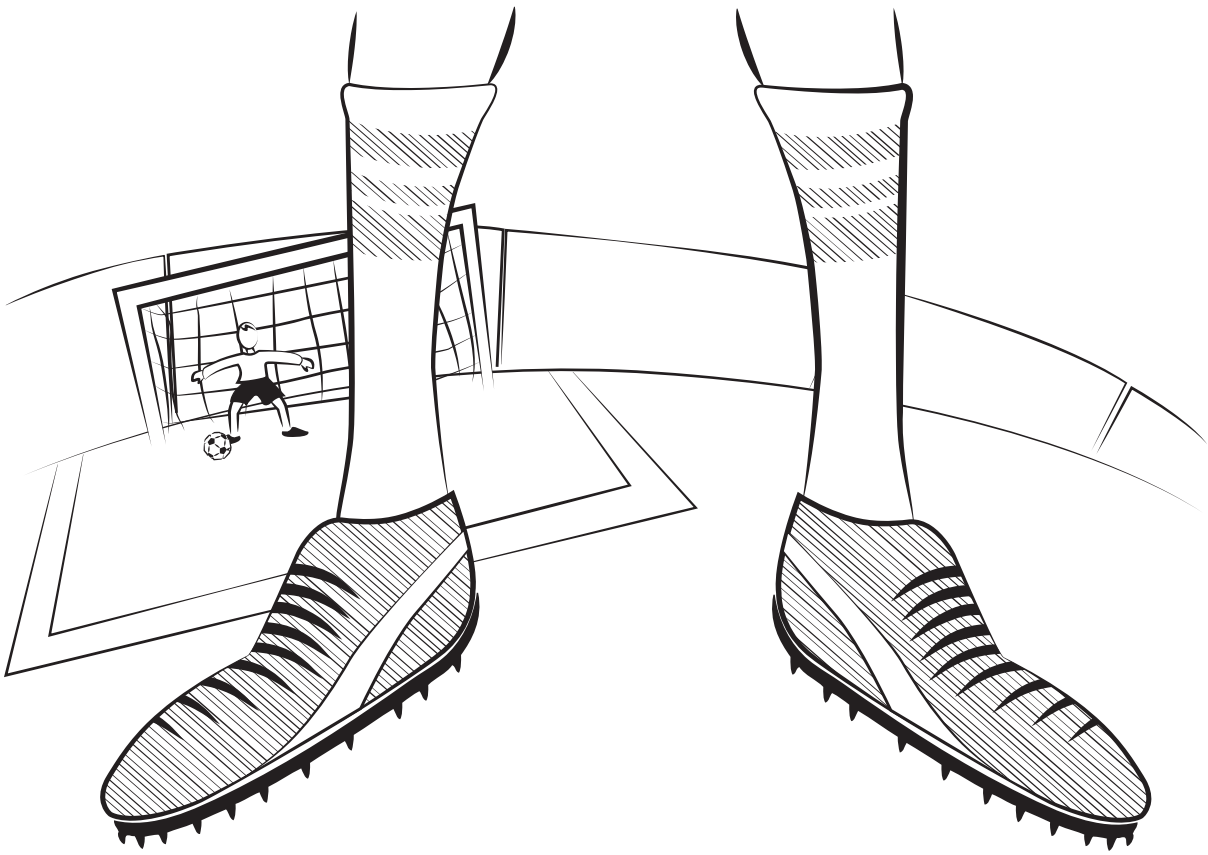
# Problems

## The Pitch



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# Standard Measurements

An interesting fact about the playing field for soccer, commonly called "the pitch" in England, is that some measurements are "firm" and some are not. Firm measurements are the same on every soccer field, but some measurements are allowed to vary from stadium to stadium. The amount of variance, however, changes from national play to international play; the variation is much smaller for international play.

The following measures are common or standard measurements for every pitch:

**Goal:** The size of the goal is always the same. It must be 24 feet wide and 8 feet high.

**Penalty Box: T**his box—the larger box in front of the goal—is 18 yards deep and 44 yards across. If a defensive player commits a foul in his or her penalty box, the offense is given a penalty kick from the penalty spot. That spot is always located 36 feet from the goal.

**6-Yard Box:** Marked on the pitch is a smaller box, called the *goal area,* which is 20 yards across and 6 yards deep. The goal is centered on this box; that means this box extends 3 yards out from each side of the goal.

**Midfield Circle:** The circle in the center of the field has a 10-yard radius. At the start of each half, one team puts the ball in play. No opposing player can be within that circle as the ball is put in play, and all players must be in their half of the field. In other words, no player can be over the center or midfield line as play begins.

Find the area and perimeter for each of these "required size" portions of the field. Then complete the worksheet below.

| Section of the Pitch | Area | Perimeter |
|---|---|---|
| Goal | | |
| Center Circle | | |
| Penalty Box | | |
| 6-Yard Box | | |

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