

**THE ELEMENTS OF
PLANE AND SPHERICAL
TRIGONOMETRY**

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The elements of plane and spherical trigonometry by John Gale Hun & Charles Ranald MacInnes

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CHARLES RANALD MACINNES

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PREFACE.

The subject matter of the chapters of this book devoted to spherical trigonometry has been used in pamphlet form for the last four years in Princeton University, and that of the chapters on plane trigonometry for the last three years.

The aim of the authors has been to present in as brief and clear a manner as possible the essentials of a short course in trigonometry. It has been found that the plane trigonometry may be covered in about thirty recitations, and the spherical trigonometry in somewhat less than this time.

It has been thought advisable to devote some time to drawing the graphs of simple equations in polar coördinates. The reason for this is two-fold. Firstly, because such problems aid in giving the student a clearer idea of the way in which the trigonometric functions vary as the angle is changed; and secondly, because of a very common lack of sufficient knowledge of polar coördinates on the part of students beginning the study of calculus.

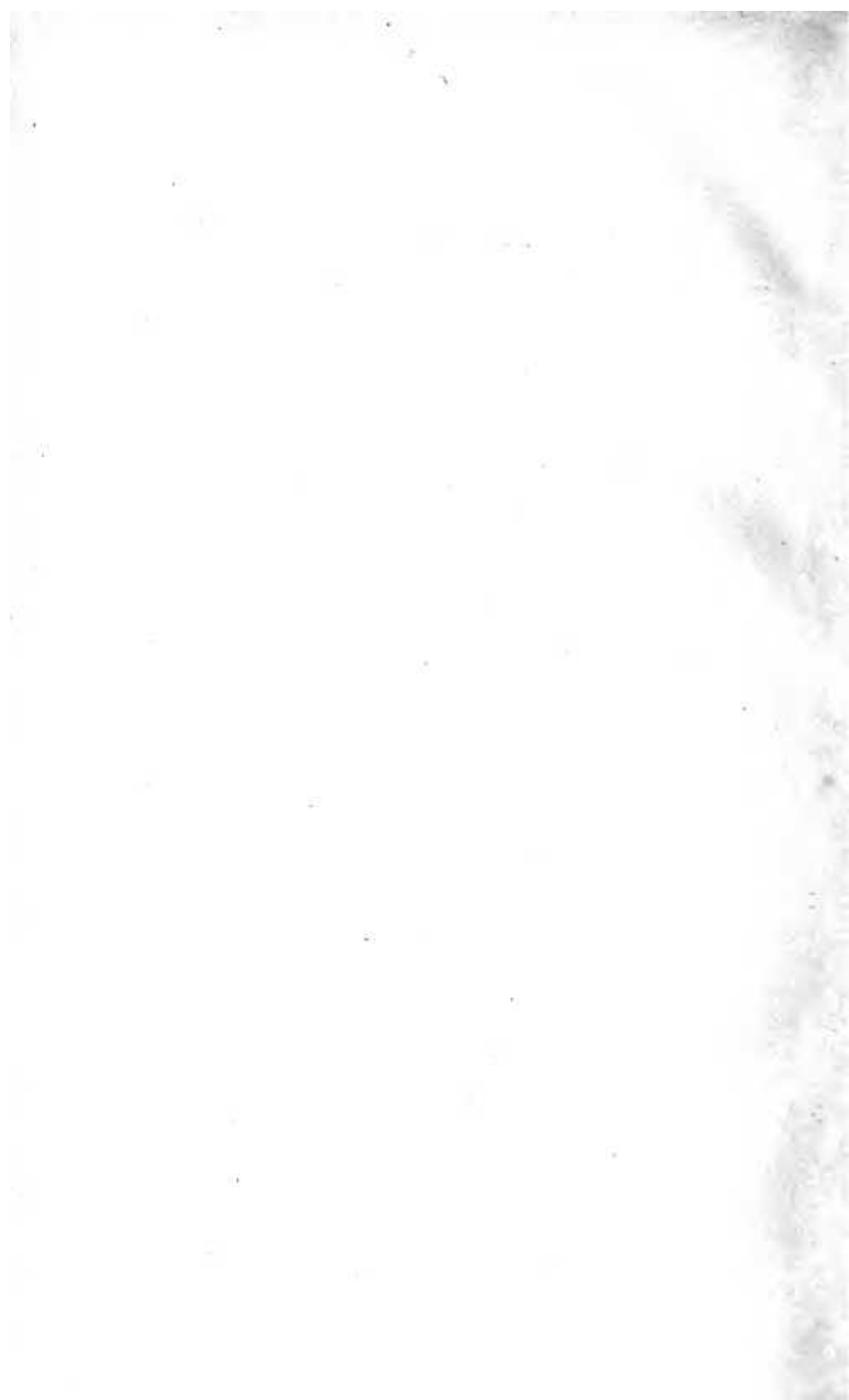
The fact that the trigonometric functions are ratios of line segments is emphasized, and their representation by means of lengths of lines is used as little as is conveniently possible.

Certain of the proofs of theorems are shorter than in many text books, and, it is hoped, thereby made more clear; notably the proofs of the formulæ for $\sin(A \pm B)$ and $\cos(A \pm B)$.

The logarithmic tables were taken from Crockett's five place tables, and the proof sheets carefully compared with Albrecht's tables. It is hoped that few errors will be found. The explanation of the tables will be found at the end of the book. It is designed that the matter there contained be given as lessons, and for this reason the student is given examples involving the difficulties usually encountered by the beginner.

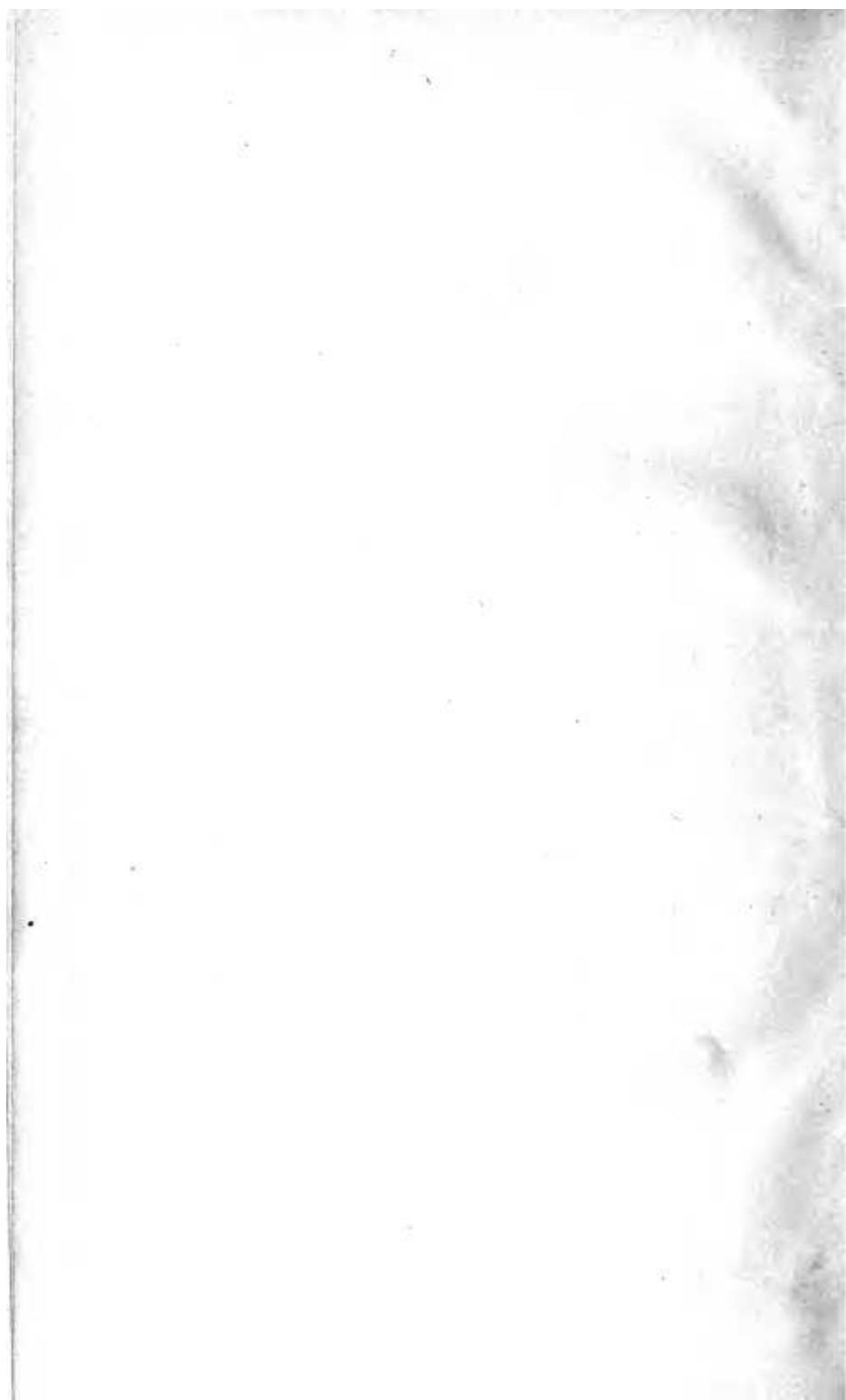
The authors wish to thank the members of the mathematical department of Princeton University who have kindly suggested several changes from the form used in the pamphlet editions.

PRINCETON, N. J.,
March 1, 1911.



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ELEMENTS OF PLANE TRIGONOMETRY.

CHAPTER I.

1. Positive and Negative Quantities. It is of fundamental importance for the student of trigonometry to realize at the outset the meaning of negative as well as of positive quantities. That a negative result may have an actual meaning is shown by the following examples: Let us suppose that a man has x dollars and that he owes y dollars. Then the difference $x - y$ denotes the number of dollars he will have after paying his debts. If now this difference happens to be negative, it will indicate the number of dollars he will still owe after he has paid out all of his cash.

As a second example consider the following: A man A is observed to pass a certain inn at exactly noon, walking at the rate of a miles per hour. At two o'clock another man B passes the same point at the rate of b miles per hour. How far will they be beyond the inn when B overtakes A ?

Let the required distance be denoted by x . A will take x/a hours to walk the distance, and B will take x/b hours. Also since A has a two-hour start on B , the latter must walk the x miles in two hours less than A requires. We therefore have the equation

$$\frac{x}{b} = \frac{x}{a} - 2$$

and hence

$$x = \frac{2ab}{b-a}.$$

Now suppose that A walks two miles and B four miles per hour. Then B will overtake A $2 \cdot 4 / (4 - 2)$ or eight miles beyond the inn. If on the other hand A walks three miles and B two miles per hour, they will be together $2 \cdot 3 / (2 - 3)$ or -12 miles beyond the inn. The interpretation of this