PROBLEMS IN ASTRONOMY, SURVEYING, AND NAVIGATION: WITH THEIR SOLUTIONS

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ASTRONOMY, SURVEYING,

AND

NAVIGATION:

WITH THEIR SOLUTIONS.

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PREFACE.

THE following pages have been drawn up chiefly with the object of facilitating *self-instruction* in the principles of Navigation and of Nautical Astronomy. Designed for the use of all parties interested in navigating ships, they are especially adapted for those who have to rely on their own exertions for the knowledge which they may require.

The theory of Navigation is treated concisely and familiarly. When that is learned in connexion with the rules derived from it, the subject assumes a more attractive form, and retains firmer hold on the mind.

By means of a few practical rules, the attention of seamen is drawn to the importance and method of correcting the compass for the local deviation arising from the effects of the induced magnetism of the iron on board. The examples under each rule have been added at the suggestion of several naval instructors, who have thought that a series of easy examples would tend to familiarise

their pupils with the rules; and in order still further to meet their wishes, additional copies of this part of the book have been struck off and bound in a separate volume, with a view to its adoption as a class-book.

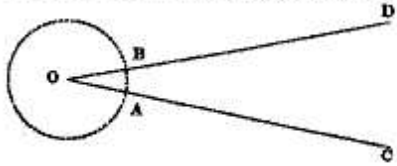
Sept. 10, 1849.

PROBLEMS

IN

ASTRONOMY, SURVEYING, AND NAVIGATION.

When a line joining any two points in space is accessible throughout its whole extent, it may in general be measured by the successive application of some line of a known length; but when it is inaccessible, or cannot be directly measured, we may obtain its length by considering it the *side of a triangle*, if we already know, or can find by observation, a sufficient number of parts of the triangle to enable us to apply one or more of the rules of Plane Trigonometry. It is thus that the mensuration of inaccessible lines of any length is found by means of that of accessible lines and angles.



The angle DOC, contained by lines drawn from a point, O, to two remote objects, C and D, may be measured by placing a circle in the plane passing through the two objects, and having its centre at the angular point, O: the straight edge of a ruler being then placed on the circle so as to pass through its center, and, by means of

sights placed over it, directed first to one object and then to the other, the arc, AB, of the circumference between the two positions of the ruler can be found; this is manifestly the measure of the angle O.

The principal instruments for measuring angles are the theodolite and sextant. A Theodolite is the most convenient instrument for measuring horizontal and vertical angles: it is composed of two circles having their planes perpendicular to each other. When the instrument is used, one of the circles is placed in a horizontal plane, by means of levels; on this circle horizontal angles are measured; on the other are measured vertical angles, whether of elevation or depression (that is, whether the object is above or below the horizontal line). A Sextant is employed to measure angles contained in any plane whatever. It is more suited for observing angular distances of heavenly bodies than the theodolite; but the latter is better adapted for Surveying than the former, since it determines the horizontal angles at once; but those observed with the sextant must, when out of the plane of the horizon, be reduced to that plane by calculation, to suit them to the purposes of the survey. In order to apply the rules of Spherical Trigonometry to the solution of astronomical problems, such as finding the latitude or hour-angle of a heavenly body, it is necessary to conceive the required arc or angle to be a part of a spherical triangle, two other parts of which are previously known by means of the Nautical Almanac or otherwise; a third part is usually found by observing with the sextant the altitude of the heavenly body above the horizon, or its angular distance from some other body, according to the

nature of the problem; we thus obtain sufficient data for computing the value of the part required.

We will not stop to give particular descriptions of the theodolite and sextant: their construction will be best learned by a careful study of the instruments themselves; we shall therefore suppose the manner of adjusting and applying them to practice is known, and proceed to give a collection of problems which they enable us to solve.

SECTION I.

PROBLEMS IN SURVEYING, ETC.

[1]. (Fig. 17.) On the opposite bank of a river to that on which I stood, is a tower known to be 216 feet high; with a pocket sextant I ascertained the angle between a horizontal line drawn from my eye (supposed to be 5 feet above the ground) and its top to be 47° 56′; required the distance across the river, from the place where I stood, to the bottom of the tower.

Ans. 190·4 feet.

[2]. (Fig. 53.) BDC is a straight line to which AD is perpendicular; AD is 100 feet high, and subtends an angle at B = 36° 48′, and at C an angle = 54° 30′; find the length of the line BC. *Ans.* 205 feet.

[3]. (Fig. 17.) A field is in the form of a right-angled triangle, whose base is 200 feet, and the angle at the base is 67°; how long will a man be walking round it at the rate of 4 miles an hour?

Ans. 3 min. 21·6 sec.