COASTAL NAVIGATION

for Class and Home Study

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REFRESHER

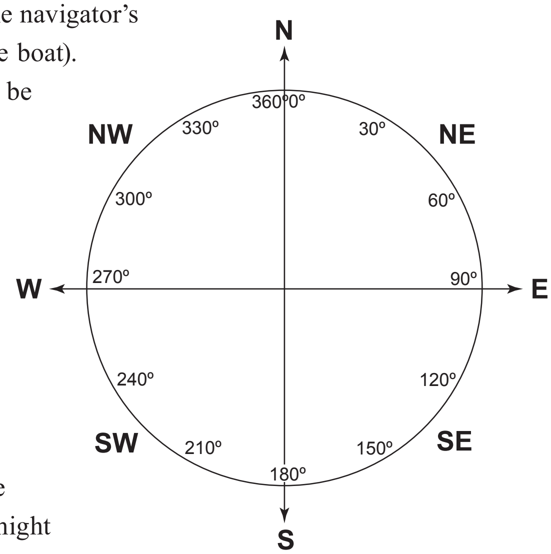
The calculations required for coastal navigation are very simple and straightforward: They consist mainly of adding and subtracting either hours, minutes and seconds of time, or degrees, minutes, and tenths-of-minutes of angles.

These concepts are not used often in everyday life, and some of us might feel a little “rusty”. The few paragraphs below might help refresh some high-school or college memories.

1. Headings, bearings and directions

Directions are noted in degrees around the compass rose, from 0° for True North, around a whole circle in a clockwise direction: East is at 90°; South at 180°; West at 270°; and North is at 360°, the same direction as 0°.

A **heading** is the direction in which the bow is pointed. It changes constantly because of wind and waves. A **bearing** is the direction of a landmark or another boat as seen from the navigator taking the bearing, and is measured in degrees and minutes of angle, clockwise, either from the **Magnetic North** (magnetic bearing, using a hand bearing compass) or from the axis of the navigator’s own boat (relative bearing, using a pelorus, aligned with the axis of the boat). A measurement from the Magnetic North, i.e. a magnetic bearing, can be converted to a true equivalent (true bearing; see Chapter 9, p. 55)



It is important, before using numbers extracted from tables and adjusted by calculations, to imagine the **order of magnitude** of the result and verify that it makes sense.

Example: For an observer in the northern hemisphere and north of the Tropic, at around 09:00 (local boat time by the sun), the sun is to the south east, with a bearing of perhaps 120° from the True North. If we see the sun at 90° to our port beam, we should be on a true heading of approximately 210°. There is usually some difference between the True North and the Magnetic North (see Chapter 9), so that the boat compass might indicate a somewhat different magnetic course. But if the boat compass reads 360° Magnetic, which implies a course in a northward direction, there is something wrong somewhere. Somebody, for instance, might have brought a portable radio with a powerful (magnetic) loudspeaker, and set it up near the steering wheel. I speak from experience.

If we want to go back from Hawaii to Vancouver and, after careful measurement on the chart, we find that we should follow a heading of 230°, we have placed our protractor upside down on the chart: the course is more like 050°, to the NE.

A while back, an airline pilot on a Boeing 737 took off from Maraba, Brazil, for Belem, on the mouth of the Amazon, on a 45-min flight very slightly East of North. His flight plan called for a heading of 27° Magnetic, but he typed 270 in his flight computer, flying into the sunset on autopilot. He should have typed 027. More than three hours later, he ran out of fuel and landed, in total darkness, deep in the Amazon jungle. Most passengers survived the blind crash-landing in the trees.

2. Symbols for times and angles

The symbols for time are: **h** (hours); **min** (minutes); and **s** (seconds). The symbols for angles are **°** (degrees); and **'** (minutes). The seconds of angle are no longer used: they have been replaced by decimals, as in 15° 45.3'.

3. Addition and subtraction of times or angles

Notwithstanding the valiant efforts by the French, shortly after the 1789 Revolution, to use the decimal system everywhere, dividing the year into 10 months and the right angle into 100 degrees, the force of habit prevailed, and the world is still using the Babylonian model built on a base of 60. After 5000 years of use, it's hard to suddenly switch to another system. There are still, therefore, 60 seconds in a minute of time, and 60 minutes in an hour. And there are still 60 minutes of angle in a degree of angle.

The use of the same units (minutes) for time and angle, and for angles and temperatures (degrees) adds to the confusion. A student asked, one day, if it was "clear water or the right angle which boils at 90°?"

3.1 Additions

When the result of the addition is more than 60 minutes or seconds of time, or degrees and minutes of arc, then 60 should be removed from the total, and one unit added to the category above. Adding 40 minutes of time to 50 minutes results in 90 minutes. This is more than 60. Remove 60, which leaves 30 minutes, and add one hour, i.e. **one** in the category above the minutes: the result is **1** h and 30 min. Same process with the angles.

Example 1: Adding angles: 122° 40.8' + 280° 32.6'

122° 40.8'	
+ **280° 32.6'**	Let us add the minutes of angle first:
~~73.4'~~	There are more than 60 minutes. We remove 60', and add one degree:
1° 13.4'	We now add the degrees:
403° 13.4'	There are more than 360°. We remove 360°.
043° 13.4'	

Example 2: Adding times: 14 h 42 min 53 s + 05 h 37 min 47 s

14 h 42 min 53 s	
+ **05 h 37 min 47 s**	Let us add the seconds first:
~~100 s~~	There are more than 60 seconds. We remove 60 s, and add one minute:
1 min 40 s	We now add the minutes:
~~80 min 40 s~~	There are more than 60 minutes. We remove 60 min, and add one hour:
1 h 20 min 40 s	We now add the hours:
20 h 20 min 40 s	

3.2 Subtractions

When we cannot subtract minutes of angle because the number of minutes which we need to subtract is larger than the number of minutes from which they must be subtracted, we simply take one degree off the top number and convert it into 60 minutes of angle, which we add to the number that was too small.

The same trick can be used for time: When we cannot subtract either the minutes or the seconds because their numbers are larger than the numbers of minutes or seconds from which they must be subtracted, we simply take one hour (or one minute), and convert it into 60 minutes (or 60 seconds) which we add to the number which was too small. If we cannot subtract the degrees, we simply add 360° to the top number.

Example 3: Subtracting angles: 122° 32.6' - 018° 40.8'

121° 92.6'	
~~122° 32.6'~~	Remove one degree and add 60 minutes (above).
− 018° 40.8'	
103° 51.8'	

Example 4: Subtracting times: 14 h 31 min 47 s – 05 h 42 min 53 s

13 h	90 min	107 s	
~~14 h~~	~~30 min~~	107 s	2. Remove one hour and add 60 minutes (above).
14 h	**31 min**	**47 s**	1. Remove one minute and add 60 seconds (above).
−05 h	**42 min**	**53 s**	
08 h	**48 min**	**54 s**	

We cannot subtract 53 s from 47 s. Remove one minute from 31 min and add 60 s to the 47 s (= 107 s). We cannot subtract 42 min from 30 min. Remove one hour from 14 and add 60 min to the 30 min (= 90 min). We can now subtract 5 h from 13 h; 42 min from 90 min; and 53 s from 107 s.