Name ______________________________________

Coastal Navigation Lab

One of the most fundamental tasks at sea is to be able to accurately navigate without signposts or roads. Many modern watercraft use **LORAN** (*Long Range Aid to Navigation*) or **GPS** (*Global Positioning System*) to navigate. Regardless of the size of the vessel, it is important the every ship captain know how to navigate using a variety of techniques, including ones that require no shipboard electronics. After all, if a storm or wave wipes out your ship's electronics, LORAN and GPS will be useless! In such an instance, basic navigation techniques—like the ones we will use in this lab—could well save your ship, and your life.

For this lab, you will complete the worksheets individually and include them in your lab notebook, but you will work as a group to complete the overlay, which your instructor will check off at the end of the period.

In this lab, you will learn basic methods of **ded reckoning** navigation, short for "deduced reckoning," and sometimes spelled "dead reckoning." It is based upon the use of a compass, a marine chart of the coastline, knowledge of local currents, and an estimate of your ship's speed. You will also learn how to locate your position using **triangulation** on known landmarks.

The marine chart is the basic tool to navigate at sea. Such charts show coastal features, harbor information, bathymetric soundings, and navigation dangers. This exercise uses the **San Diego to Santa Rosa navigation chart**. This chart utilizes the following information:

Map Distances

The scale ratio of the San Diego to Santa Rosa Chart is **1:234,270** that means that 1 inch on the map is equal to 234,270 inches across the water, or <u>3.2 nautical miles per inch</u>.

NOTE: One easy way to measure distance is to use the <u>minutes of latitude</u> on the right side of the map. <u>One minute of latitude is exactly equal to 1.0 nautical mile</u>. Scale off the distance you are trying to measure on a piece of paper and put it on the minute scale to get the distance.

Compass Headings

The second feature you will see on the chart is a **compass rose** (in purple). It is comprised of two circles representing true (outer) and magnetic (inner) compass bearings. The direction from one point to another is called a <u>compass bearing</u> or <u>heading</u>. For this lab, we will use true geographic bearings, which means using the outer circle of the compass rose. <u>Please use only the outer circle when determining your compass bearings!</u>

Current corrections

Your boat will be acted upon by currents generated from wind and waves. To correct for these, one must plot each leg of the course to be navigated and then calculate the drift of the current during the time that the boat is being driven along that the course. You will need is the relationship of travel time, distance, and speed, which are related as follows:

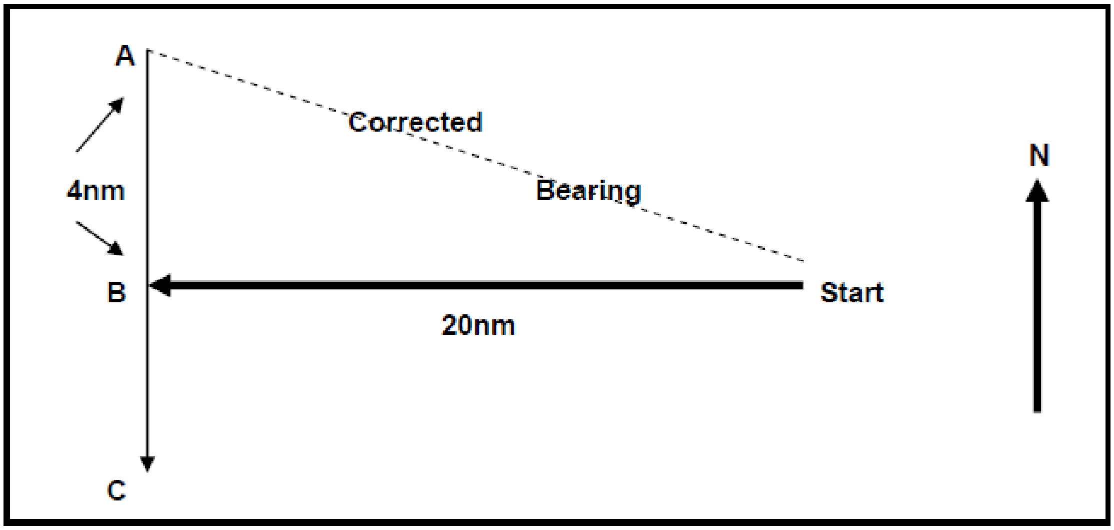
Speed = Distance / Travel Time

Travel Time = Distance / Speed

Distance = Speed x Travel Time

Here is an example for a correction of a boat traveling for 2.0 hours at 10 nm/hour at a bearing of 270 degrees (west) with a current of 2.0 nm/hr flowing from 0 degrees (i.e. from north to south).

The boat traveled: 2.0 hrs x 10 nm/hr = **20 nm**
The current pushed it: 2.0 hrs x 2 nm/hr = **4 nm** (south)

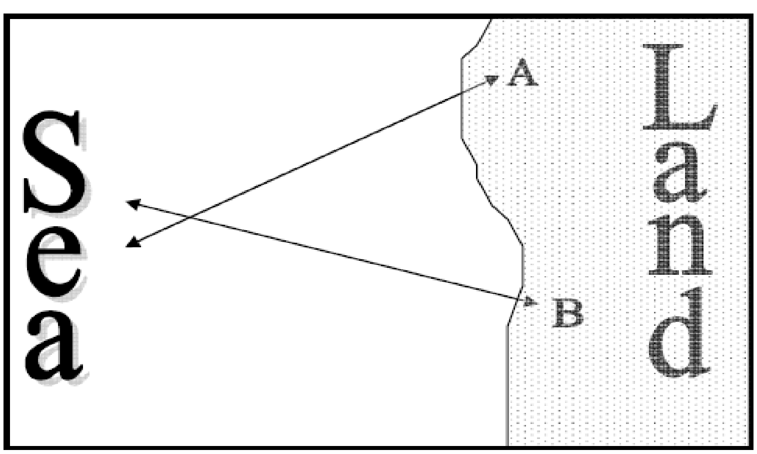


If you want to end up at point B at the end of 2 hours you must aim for point A. If you just drive the boat towards point B you will end up at point C. It's like throwing a ball to a running person and leading them a little bit. This is called a corrected bearing or heading.

Triangulating position at sea

One way to fix your position at sea is to determine the compass heading to two visible landmarks along the coast (such as points A and B below). When you plot the headings on your chart, your position is indicated where the lines cross. This is called triangulation.

When plotting triangulation measurements taken at a point (a boat etc.), start at the compass rose and move to landmark. When the parallel rules are on the landmark, draw your line.



Navigating using the San Diego to Santa Rosa Navigation Chart

Show all conversions and calculations for the lab. You will plot your course on the overlay and answer the questions below as you proceed through the lab. There are 4 legs to plot.

Leg 1

From: **32°45' N** and **117°15' W**
To: **33°25' N** and **117°37' W**
Boat speed is **20 nm/hr**
There is no current.

1) From what harbor are you departing?

2) What is your heading, distance, and travel time to the end of Leg 1 (to the San Clemente pier)? *Indicate units after all of your numbers.*

Heading: ________________ Distance: ________________ Travel time: _______________

Leg 2

From: End of Leg 1
To: **33°21' N** and **118°19' W**
Boat speed is **20 nm/hr**
There is no current.

3) Where are you spending the night at the end of Leg 2?

4) What is your heading, distance, and travel time to the end of Leg 2? *Indicate units after all of your numbers.*

Heading: ________________ Distance: ________________ Travel time: _______________

Leg 3

From: End of Leg 2
To: **32°40' N** and **117°58' W** (30-Mile Bank)
Boat speed is **20 nm/hr**
Current is flowing at 3.0 knots from 300°

5) What is your heading, distance, and travel time to the end of Leg 3 (30-Mile Bank) uncorrected for current? *Indicate units after all of your numbers.*

Heading: ________________ Distance: ________________ Travel time: _______________

From the end of Leg 3 (the 30-Mile Bank), draw a line that shows the direction of the current. (Use the parallel rulers and step them over from the compass rose to the end-point.) If you do not correct for the current, your vessel will end up somewhere along this line down-current of your intended destination.

6) During the time it takes you to travel Leg 3, how far will the current have flowed, in nm?

7) Your answer to 6) above gives you the distance that your vessel will be pushed off course by the current. Based on this, plot a point on the chart to show where your vessel would end up if you did not correct for the current. Then subtract that distance from the up-current side of your end-point, and put another point on the chart that represents your corrected destination. The idea here is that, if you aim for this point, the current will keep you on your intended course, and you will end up at your intended destination.

8) What is the latitude and longitude of your **corrected** (for current) destination?

Latitude: _______________ Longitude:________________

9) What is your **corrected** (for current) heading, distance, and travel time?
Indicate units after all of your numbers.

Heading: _______________ Distance: _______________ Travel time: ______________

Leg 4

From: End of Leg 3
To: entrance to Mission Bay Harbor
Boat speed is **20 nm/hr**
Current is flowing at 2.0 knots from 300°
Departure time is 12:00 noon.

10) What is your heading, distance and travel time to the end of Leg 4 (entrance to Mission Bay Harbor) uncorrected for current? *Indicate units after all of your numbers.*

Heading: _______________ Distance: _______________ Travel time: ______________

From your end-point for Leg 4 (entrance to Mission Bay Harbor), draw a line that shows the direction of the current. (Don't worry if your line runs onto land; this is just to make the correction.)

11) During the time it takes you to travel Leg 4, how far will the current have flowed, in nm?

12) Using your answer to 11), plot a point on the chart to show where your vessel would end up if you did not correct for the current. (Don't worry if looks like your vessel is going to end up on land; this is just to make the correction.) Then subtract that distance from the up-current side of your end-point, and put another point on the chart that represents your corrected destination.

13) What is the latitude and longitude of your **corrected** (for current) destination?

Latitude: _______________ Longitude:________________

14) What is your **corrected** (for current) heading, distance, and travel time? *Indicate units after all of your numbers.*

Heading: _______________ Distance: _______________ Travel time: ______________

Suddenly there is an explosion! Your vessel begins to sink! Just before you jump into your life raft, you are able to make the following readings and observations:

- Ship clock reads **1:00pm** (exactly one hour after you started along Leg 4)
- Compass bearing to the tip of Point Loma = **100°**
- Compass bearing to Point La Jolla = **65°**
- Loran/GPS position reads **32°48' N** and **117°58' W**
- The lights and other electronics are either flashing or have shut down, suggesting damage to the electrical system.

***** Determine your position where you sank using three independent methods *****
(**ded reckoning**, **triangulation**, and **Loran/GPS**)

15) Plot on the chart your estimated position using **ded reckoning** (i.e. your travel time and speed along Leg 4). ***Label this point DED on your chart.***

16) Plot on the chart your estimated position using **triangulation**, based on the compass bearings to Point Loma and Point La Jolla. (To do this, orient your parallel rulers at the compass rose along the bearing, step them over to the landmark, and then draw a line along the edge of the ruler from the landmark out into the ocean.) The intersection of the two triangulation lines is your estimated position. ***Label this point TRI on your chart.***

17) Plot your estimated position using the **Loran/GPS** reading. ***Label this point GPS on your chart.***

18) Of the above three estimates of your position where you sank, which one is likely wrong, and which two are likely close to correct? Explain your reasoning.

19) You are drifting in your life raft at 2.0 knots with the current flowing from 300°. You drift for hours and eventually run aground. Where have you most likely come ashore? List the latitude/longitude coordinates.