Navigation Basics

Regional Based Training for Div's 01, 13, 18, 22

04 May 2019
Instructors

- **Ron Kudla** (Flotilla 1-3)
  - ADSO-OP, ADSO-MT, IPFC
  - 9 years of service, Coxswain
  - 870 hrs of Auxiliary Marine Patrols

- **Rudy Vilardi** (Flotilla 1-3)
  - Former SO-MT, FC, VCDR
  - 23 years of service, Coxswain
  - 682 hrs of Auxiliary Marine Patrols
What We’ll Discuss

- Determining your position on a nautical chart
  - latitude and longitude
- Using the Speed-Time-Distance formula
- Course plotting
Great Circles

- Formed by planes passed through earth’s center.
- Separate earth into two hemispheres.
- Shortest distance between any two points lies on great circle connecting them.
Equator

- Great circle equidistant between geographic poles called equator.
- Forms demarcation between north & south hemispheres.
Small Circles

- Plane passed through earth that does not touch the earth’s center.

- Small circles parallel to equator termed latitude.

**Latitude** is one of two reference coordinates used to describe position on the earth.

Small Circle:
L = 30º N

Equator
Parallels of Latitude

30°
Meridians of Longitude

Great circles that pass through the polar axis of rotation.

- $0^\circ$ Longitude passes through Greenwich, England.
- Commonly called the Prime Meridian.

Measured east and west through $180^\circ$.

Provides the second coordinate - longitude.
Meridians of Longitude

- $\text{Lo} = 110^\circ \text{E}$
- $\text{Lo} = 50^\circ \text{E}$
- $\text{Lo} = 70^\circ \text{W}$
- $\text{Lo} = 130^\circ \text{W}$

Polar Axis
Positions On The Surface Of The Earth

System Of Coordinates

- Lines of **Latitude** and **Longitude** provide a precise means of determining position on the earth’s surface.
- These lines are formed by passing imaginary planes (flat surfaces) through the earth.
Describing Location

Latitude (L)
- Angular distance N or S of equator
- Equator = 0°
- Must indicate N or S
- North pole = 90° N

Longitude (Lo)
- Angular distance E or W of prime meridian
- Prime Meridian = 0°
- Must indicate E or W
- Washington, D.C. is about 77° W
Describing Location

L 72.06° N
Lo 37.42° W
Definitions

- **Latitude** lines measure angular distances (in degrees) from the equator.
- **Longitude** lines measure angular distance (in degrees) from the prime meridian.

  Each degree can be divided into 60 minutes (60’)
  Each minute can be divided into 60 seconds (60”)

  In navigating we most often use tenths of minutes rather than seconds.

\[
40.25^\circ = 40^\circ-15.0’ = 40^\circ-15’-00”
\]
\[
073^\circ-30.25’ = 073^\circ-30’-15”
\]
Definitions

- 1 degree of arc = 60 minutes
- 1 minute of arc = 60 seconds

Latitude / Longitude expressed as:
- dd-mm-ss  or  dd-mm.mm

Example: 30°-26’-45”  or  30°-26.75’

Do not forget!
Let’s Practice

Convert these positions from decimal degrees to Degrees and Minutes:

- **40.50° N latitude**
  - 40°-30’ N latitude
- **35.75° N latitude**
  - 35°-45’ N latitude
- **073.25° W longitude**
  - 073°-15’ W longitude
- **073.40° W longitude**
  - 073°-24’ W longitude

**Multiply decimal x 60**
More Practice

Convert these positions from Decimal Degrees to Degrees and Minutes:

- 40.66° N latitude • 40°-39.6’ N latitude
- 35.77° N latitude • 35°-46.2’ N latitude
- 073.23° W longitude • 073°-13.8’ W longitude
- 073.46° W longitude • 073°-27.6’ W longitude

Multiply decimal x 60
More Practice

Convert these positions from Degrees and Minutes to Degrees-Minutes-Seconds:

- 40°-39.5’ N lat
- 35°-46.25’ N lat
- 073°-13.8’ W lon
- 073°-27.6’ W lon

• 40°-39’-30” N lat
• 35°-46’-15” N lat
• 073°-13’-48” W lon
• 073°-27’-36” W lon

Multiply decimal x 60
More Practice

Convert these positions from dd-mm-ss to dd-mm.mm:

- 40°-39’-30” N lat
- 35°-46’-15” N lat
- 073°-13’-45” W lon
- 073°-27’-50” W lon

- 40°-39.50’ N lat
- 35°-46.25’ N lat
- 073°-13.75’ W lon
- 073°-27.83’ W lon

Divide “seconds” by 60
The Nautical Chart
Scales for Lat. & Lon.

- Minutes of Lat. & Lon. typically delineated along chart edges.
  - Bar color alternates, black to white, for ease of reading.
  - Each bar divided into tenths.
Coordinates

- Latitude and longitude provide a nautical position on the earth
  - Latitude scale is found on the left and right margins of the chart
  - Longitude scale is found on the top and bottom margins

On small craft charts, latitude / longitude scales are located within the field of the chart [ie: Chart 12352]
Chart 12365

NO-DISCHARGE ZONE
(see note Z)

SPECIAL ANCHORAGE 110.1 - 110.55
(see note A)

SPECIAL ANCHORAGE 110.1 - 110.55
(see note A)

NORTHPORT HARBOR Channels are marked
d by private aids.

Channel marked by private aids to Northport Basin.
Dividers

- Used to measure latitude and longitude coordinates
- Drawing compass is similar to dividers
Determining Latitude Coordinate

One point is placed on spot of interest and other point is on a line of latitude

Divider is transferred to latitude scale

Read as degrees, minutes, and seconds (N)
Determine Latitude

Use dividers and the latitude scale to determine the latitude of a position on the nautical chart.

**Step 1**
Put one point of the dividers on the position you wish to determine the latitude of (A).

**Step 2**
Extend the dividers so the other point touches the nearest latitude line on the chart.

**Step 3**
Move the dividers (and their fixed width position) to the latitude scale on the side of the chart by tracing the latitude line you touched in step 2.

**Step 4**
The latitude scale is read here.

Note that this latitude is recorded as 35° 12.0’N as indicated on the scale: 35 degrees, 12 minutes.
Determining Longitude Coordinate

- One point is placed on spot of interest and other point is on a line of longitude
- Divider is transferred to longitude scale
- Read as degrees, minutes, and seconds (N)
Determine Longitude

- Repeat the process to determine Longitude, but be sure to use the Longitude scale along the bottom of the chart.
Example #1

Determine Latitude (L) and Longitude (Lo) of the Red #8 Buoy, Fl R 4s, in the North Channel off of Nicoll Point in Heckscher State Park
L 40° 41’ 27” N
Lo 073° 09' 02" W
Example #2

Plot a point on the chart with the following coordinates:

L = 40° 40.25’ N

Lo = 073° 12.50’ W
Convert to dd-mm-ss

L = 40° 40.25’ N
Lo = 073° 12.50’ W

Multiply the decimal by 60

L = 40° 40’ 15” N
Lo = 073° 12’ 30” W
L 40° 40’ 15” N
Lo 73° 12’ 30” W
Distance between minutes of latitude is constant.

So, we can use latitude to measure distance!

Is this true of longitude?

No - longitude lines converge at poles.

So - distance between minutes gets smaller as you go away from equator.
What is a Nautical Mile?

- 360° in a circle
- Each circle has $360^\circ \times 60 = 21,600$ minutes
- Distance described on the earth’s surface by 1 minute of arc along a great circle is defined as 1 nautical mile
- Therefore, the circumference of the earth = 21,600 nautical miles
- 1 minute of latitude is always equal to 1 nautical mile

Circumference of earth = 24,901 statute miles
What is a Nautical Mile?

Since every minute of latitude is a minute of arc along a meridian, and since every meridian is a great circle, 1 minute of latitude is always equal to 1 nautical mile.

That makes the Nautical Mile a convenient measure of distance.
What is a Knot?

A Knot is a speed of 1 nautical mile per hour

Note that knots per hour is not a valid expression

If you travel 8 nautical miles over 1 hour time your speed is 8 knots.
Measuring Distance

- 1 Minute of Latitude  =  1 Nautical Mile
- 1 Degree of Latitude  =  60 Nautical Miles

St. Augustine, FL, is at L 30° N. How many miles north of the equator is St. Augustine?

\[ 30^\circ \times 60 \text{ NM/}^\circ = 1,800 \text{ NM} \]
More Examples

What is the distance from the equator to:
Latitude 22° 10.0’N?

\[(22° \times 60 \text{ NM/°}) + 10.0’ \times 1 \text{ NM/min} = 1,330 \text{ NM}\]

Your position: Lat 39° 49.6’N and a vessel passing you is 3 NM South.

What is the vessel’s latitude?

\[\text{Lat} = 39° 49.6’N - (3 \text{ NM} / 1 \text{ NM/min}) = 39° 46.6’N\]
Measuring Distances on the Chart

Two ways:

- **One:** Use dividers to transfer measurements taken to the Latitude scale.
- **Two:** Use distance scale found at top and bottom of chart in the same way.

Using either of these methods, how far is it in nautical miles from #8 buoy to #3 buoy in the North Channel of Chart 12352?
Some Examples:

Suppose you drive your boat at a speed of 10 Knots for 20 minutes. How far have you gone?

How fast are you going if you travel 12 Nautical Miles in 40 minutes?

How long does it take to travel 12 Nautical Miles at a speed of 15 Knots?
Computing Speed, Time and Distance

Speed x Time = Distance

12 knots x 2 hours = 24 Nautical Miles

When navigating, we usually specify time in minutes.
Speed – Time – Distance

“Sixty D Street” 60D=ST

Distance in nautical miles (NM)
Speed in knots (kt)
Time in minutes (min.)
Calculating Time, Speed & Distance

Distance = Speed x Time divided by 60
$$D = \frac{ST}{60}$$

Speed = Distance x 60 divided by Time
$$S = \frac{60D}{T}$$

Time = Distance x 60 divided by Speed
$$T = \frac{60D}{S}$$
Suppose you drive your boat at a speed of 10 Knots for 20 minutes. How far have you gone?

\[ D = S \left( \frac{T}{60} \right) = 10 \times \left( \frac{20}{60} \right) = 3.33 \text{ NM} \]
Computing Speed, Time and Distance

How fast are you going if you travel 12 Nautical Miles in 40 minutes?

\[ S = \frac{60D}{T} = 60 \times \left( \frac{12}{40} \right) = 18 \text{ knots} \]
Computing Speed, Time and Distance

How long does it take to travel 12 Nautical Miles at a speed of 15 Knots?

\[ T = \frac{60 \times D}{S} = \frac{60 \times 12}{15} = 48 \text{ min.} \]
Course Plotting

Direction is measured clockwise from North and expressed in degrees

- East is 090°
- South is 180°
- West is 270°
- North is 360° or 000°
Course Plotting

Direction is measured clockwise from North and expressed in degrees.
Course Plotting

- Find course (direction) from buoy “A” to buoy “B”

170°
Parallel Rules

- Consists of a pair rules joined by two or more swinging hinges
- Serve as a straight edge for plotting
- Helps transfer a plotted bearing line across the chart to compass rose
Rolling Parallel Rules

- One straight edge
- Moves across the chart on a long roller
Protractor Plotting Tool
Course Plotter

May be easier to use than parallel rules, particularly in cramped spaces
You are on patrol in Port Jefferson Harbor and the Coxswain asks you to plot a course to the green #1 buoy in the southeast quadrant of Smithtown Bay.

He further instructs you to maintain a minimum distance of ½ mile offshore during your route.

Begin your journey at 1300 from Port Jefferson Harbor entrance buoy [G “1” Fl G 2.5s] and end the journey at G “1” Fl G 4s in Smithtown Bay off of West Meadow Beach.

If you travel at 15 knots, what will be your ETA to the destination?

Plot and label all courses and distances on Chart 12364.
Latitude and Longitude locate your position on the earth

- Portions of a degree are expressed in minutes or minutes and seconds (60’ = 1°, 60” = 1’)

Can use Latitude to measure distance

- 1 minute of Lat = 1 NM

Speed-Time-Distance Formula

- 8 knots = speed of 8 NM per hour

Course Plotting
Thanks for Participating