

Location, Direction, and Distance on Nautical Charts

Please read Appendix III in the textbook for reference.

Learning Objectives for the first nautical chart Lab

1. Use the latitude-longitude system to describe location on a map or chart.
2. Describe the angles used to define latitude and longitude within a globe.
3. Use a scale to determine distance between two points on a map or chart.
4. Describe a compass direction in terms of a bearing.
5. Identify the locations of true north and magnetic north on the globe, as well as the reasons for their positions.

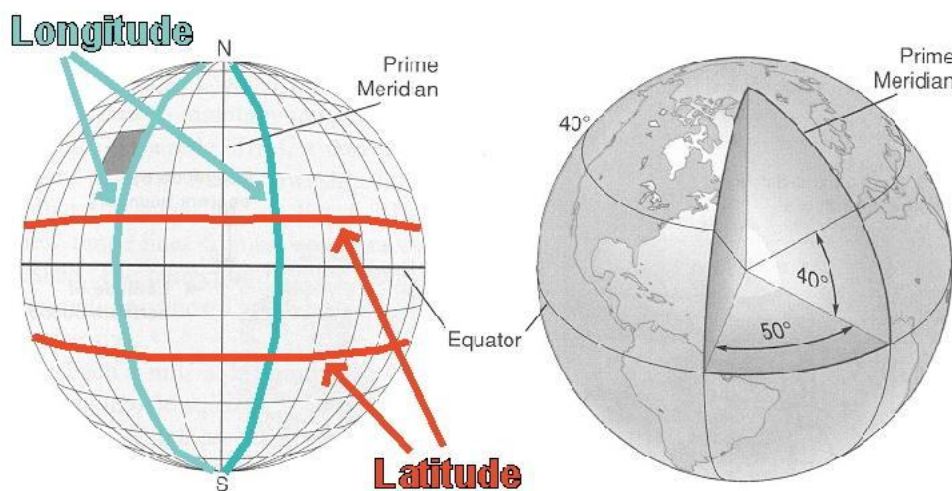
What is a chart?

A chart is a special kind of map that is used for nautical navigation. It usually shows the bathymetry (water depths) of coastal areas, navigational features such as buoys and lighthouses, and the shape of the coastline. The chart we will use in this lab is NOAA chart 18685 of Monterey Bay.

I Location, location, location: all about Latitude and Longitude

Lines of latitude and longitude are used to locate positions on maps and charts. Lines of latitude are imaginary lines that run parallel to the equator. They are labeled by their angular distance north or south of the equator as shown below. Lines of longitude run from pole to pole and are labeled by their angular distance east or west of Greenwich, England. The north-south line that runs through Greenwich, England is known as the Prime Meridian.

The angular unit of “degrees” is traditionally broken into units called “minutes.” There are 60 minutes in a degree. In other words, a minute is $1/60^{\text{th}}$ of a degree.



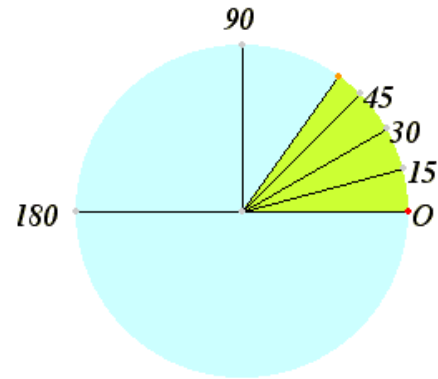
1. Label a few examples of lines of latitude and lines of longitude on the globe above left.

Lines paralleling the equator are lines of latitude. Lines extending from the north to the south pole are lines of longitude. See the left part of the image above.

Lines of latitude and longitude are named using angles. Angles are measured in units of degrees.

The Degree

The degree is the basic unit of measure for an angle. A right angle is 90° , a straight line is 180° , and there are 360° in a circle.



Fractions of Degrees = Minutes

Sometimes, we need to describe fractions of degrees, like when we are describing location on the surface of the Earth in terms of angular measurements like latitude or longitude.

Degrees are traditionally broken into units called minutes. There are 60 minutes in a degree. In other words, a minute is $1/60^{\text{th}}$ of a degree.

Fractions of Minutes: There are two methods:

a. Decimal Minutes: the minutes are broken into decimal units using the usual tenths, hundredths, thousandths, etc... The Monterey Bay NOAA Nautical Chart uses degrees and decimal minutes.

b. Seconds: There are 60 seconds in a minute. In other words, a second is $1/60^{\text{th}}$ of a minute. USGS topographic maps use degrees, minutes, and seconds.

To Designate areas E or W of the Prime Meridian and N or S of the Equator

We use:

the letter "E" to designate areas *east* of the Prime Meridian

the letter "W" to designate areas *west* of the Prime Meridian

the letter "N" to designate areas *north* of the equator

the letter "S" to designate areas *south* of the equator

Use of the letters "N", "S", "E", or "W" is **required** when describing angles using the minute system.

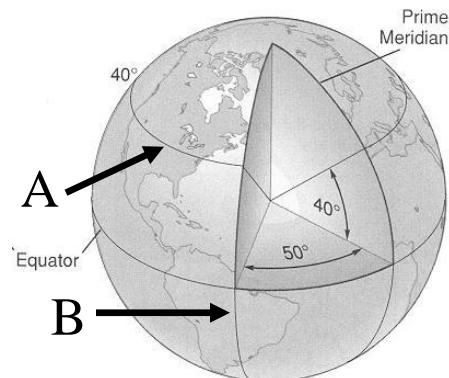
Examples:

A. Line "A" to the right, a line of latitude forty degrees and zero minutes north of the equator, is written **$40^\circ 0.0' \text{N}$** .

B. Line "B" to the right, a line of longitude fifty degrees and zero minutes west of the Prime Meridian, is written **$50^\circ 0.0' \text{W}$** .

C. The line of longitude that lies 36 degrees and 31 minutes south of the Equator is written **$36^\circ 31' \text{S}$** .

D. The line of longitude that lies 105 degrees and 15.24 minutes east of the Prime Meridian is written **$105^\circ 15.24' \text{E}$** .



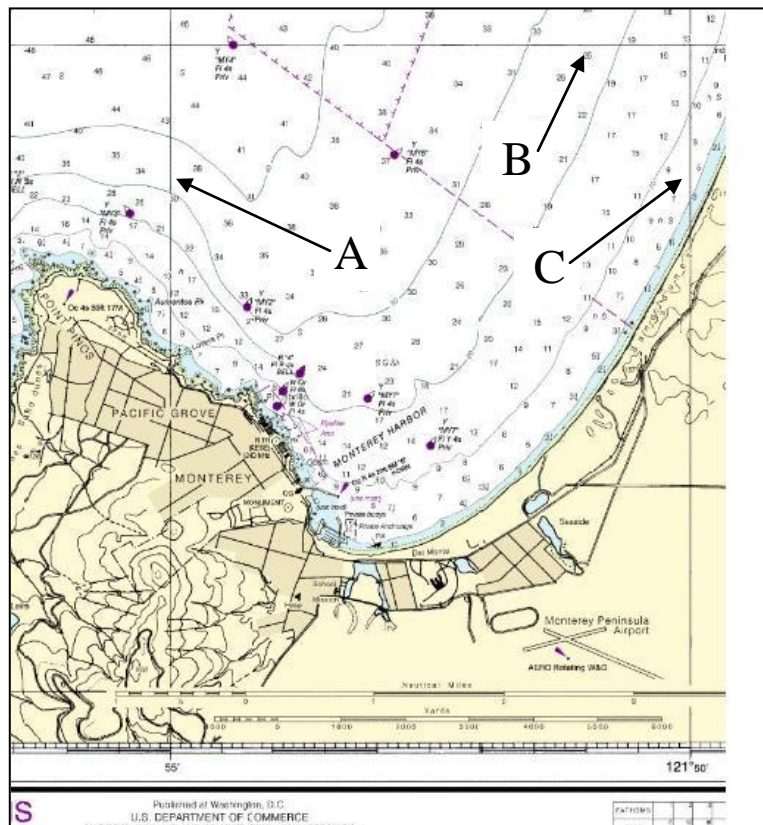
Lines of latitude and longitude on the globe

Fill in the columns on the right by writing the angle used to communicate the latitude or longitude described on the left. Use decimal minutes. First one completed as an example.

Written Description	Angle	Latitude or Longitude?
The area 60 degrees and 5.5 minutes north of the equator	60°5.5'N	Latitude
The area 79 degrees and 54.9 minutes east of the prime Meridian	79°54.9'E	Longitude
The area 36 degrees and 34.8 minutes south of the equator	36°34.8'S	Latitude
The line 175 degrees and 33.2 minutes west of the Prime Meridian	175°33.2'W	Longitude
The line 82 degrees and 46.5 minutes north of the equator	82°46.5'N	Latitude
The line 48 degrees and 21.2 minutes east of the Prime Meridian	48°21.2'E	Longitude

Lines of latitude and longitude on the Monterey Bay Chart

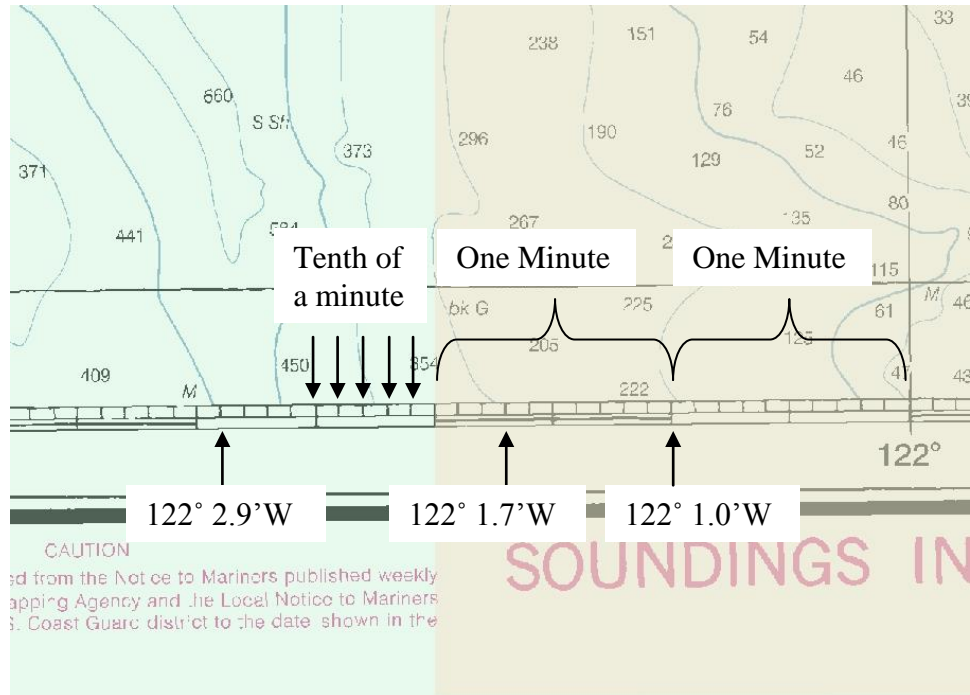
Complete the table below. What are the latitudes or longitudes for the following solid lines of latitude or longitude printed on the chart? Each question refers to a solid line on the nautical charts in class. Use decimal minutes. Be sure to include a "N" or "S" for latitudes and an "E" or "W" for longitudes, as appropriate. These letters are part of the answer. The first one is done for you.



Location – all of these refer to solid lines representing lines of longitude or latitude on the chart.	Longitude or Latitude
Line of longitude that intersects Lovers Point in Pacific Grove (line A above)	121° 55' W
Line of latitude nearest the Indian Head Beach (Line B above)	36° 40' N
Line of longitude nearest Indian Head Beach (Line C above)	121°50'W
Line of latitude that intersects the Cypress Point bouy	36° 35' N
Line of latitude a few miles north of Moss Landing	36° 50' N
Line of longitude nearest and west of Cypress Point	122° 0' W
Westernmost line of longitude shown as a solid line on the chart	122° 5' W

Reading Tenths of Minutes from the Monterey Bay Chart

The scale along the edges of the chart is divided into minutes and tenth of minutes. The minutes are shown by the solid and open areas along the scale. There are five minutes between each solid line of latitude or longitude; each of these are labeled with the number of minutes that they represent. Each of the minutes is



divided into tenths of minutes by a tick mark. Examples are shown above.

1. What are the latitudes and longitudes of the boundaries of the Monterey Bay chart? Complete the table. Be sure to include a “N” or “S” for latitudes and an “E” or “W” for longitudes, as appropriate.

Chart boundary	Monterey Bay chart
Western	Longitude: $122^{\circ}06.4'W$
Northern	Latitude: $37^{\circ}02'N$
Southern	Latitude: $36^{\circ}34.6'N$

2. Why do the longitude numbers increase to the west on this chart?

Because Monterey Bay is in the Western Hemisphere and is West, not East, of Greenwich, England. As the distance between the point of interest and the Prime Meridian increases to the west, the angle describing longitude gets bigger.

3. On the Monterey Bay Chart, what is the latitude and longitude of the following places? Don't forget the “N”, “W”, “E”, or “S” where appropriate.

Place	Latitude	Longitude
Pt Pinos lighthouse	$36^{\circ}38.0'N$	$121^{\circ}56.0'W$
Pt Santa Cruz lighthouse	$36^{\circ}57.1'N$	$122^{\circ}1.5'W$

4. What feature is described by the following latitudes and longitudes?

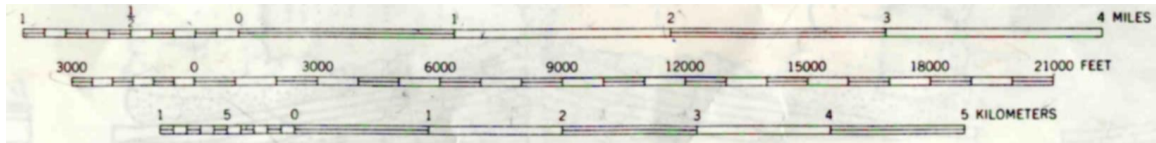
Latitude	Longitude	Location
$36^{\circ}36.7'N$	$121^{\circ}57.4'W$	Pt. Joe
$36^{\circ}57.6'N$	$121^{\circ}58.5'W$	Soquel Point
$36^{\circ}36.3'N$	$121^{\circ}53.5'W$	Monterey Harbor, or Fisherman's Wharf, or Municipal Wharf #1

II Scale -- Measuring distance

The ratio of distance on a chart or map to actual distance on the Earth's surface is the **scale**. There are two main kinds of scales.

The first is a **fractional scale** such as 1:100,000. The number to the left of the colon refers to a distance on the map in any unit of length. The number to the right of the colon refers to the distance on Earth in that same unit of length. For example, 1:100,000 means that 1 inch on the map is equal to 100,000 inches on the surface of the Earth. Or, 1:100,000 means that 1 centimeter on the map is equal 100,000 centimeters on the Earth. Fractional scales work for any unit of measure. It is the *ratio* of distance on the map to distance on the Earth's surface.

The second is a **bar scale**. The bar scale shows graphically the length of a given unit of distance is on the map. They can be used like a ruler. The diagram below is an example of a bar scale.



Large Scale vs Small Scale.

Large scale maps show objects larger and in more detail. Small scale maps show objects smaller and in less detail. A 1:50,000 scale map is larger scale (and shows more detail) than a 1:100,000 scale map.

1. What is the fractional scale of the Monterey chart?

1:50,000

2. Find the United States map entitled "Landforms and Drainage of the 48 States" on the wall near the office door in the classroom. What is its fractional scale of this map?

1:3,500,000

4. Which of the two maps is able to show similarly sized objects in more detail?

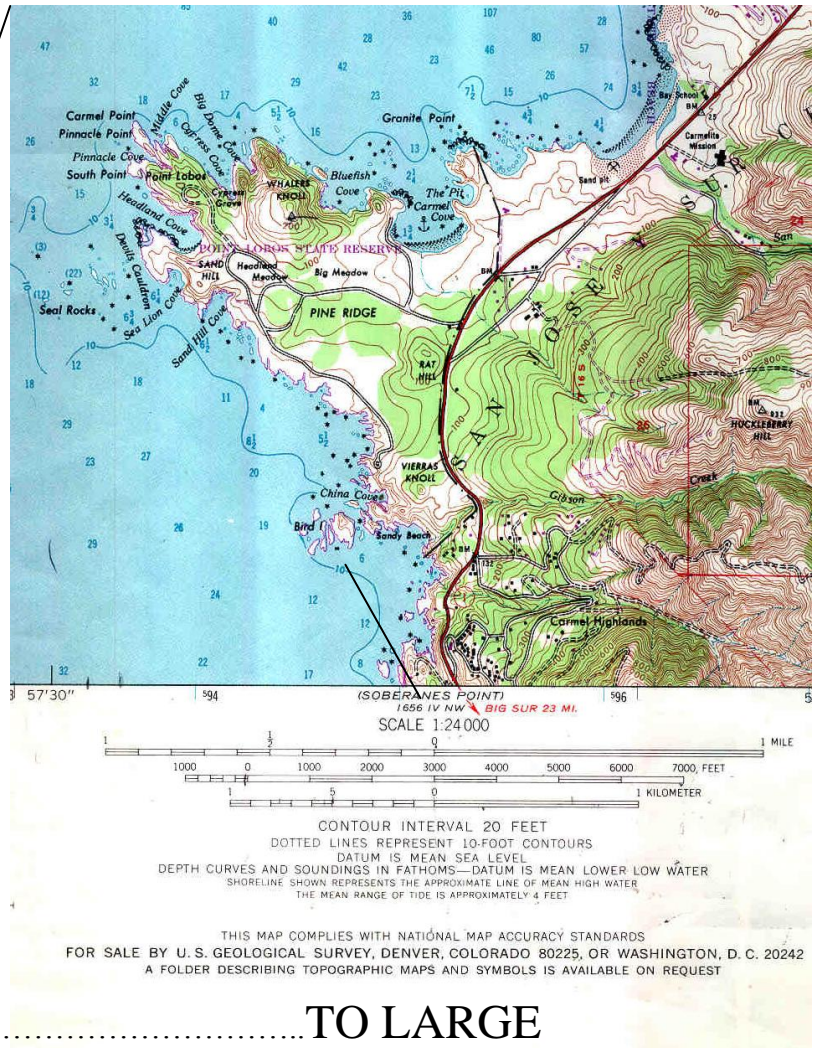
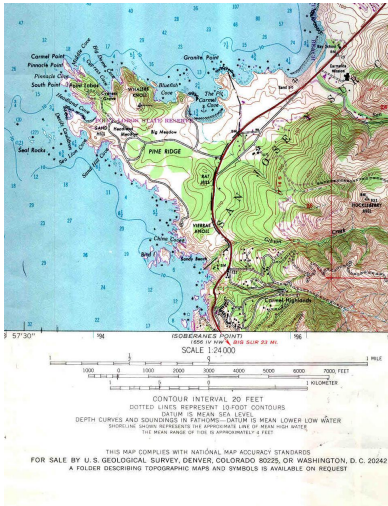
The Monterey Bay Chart. Note how much smaller Monterey Bay is on the Landforms map.

3. Is the "Landforms and Drainage of the 48 States" larger scale or smaller scale than the Monterey Bay chart? Why? Please explain your rationale.

The landforms map is smaller scale. 1/3,500,000 is a smaller number than 1/50,000. The landforms map shows objects in a smaller size than the Monterey Bay chart.

(But the Monterey Bay chart shows objects smaller in size than the landforms map.☺)

Original size



Enlarged from original.....**TO LARGE**

5. Assume that you've taken a map (shown on the left above) and enlarged it on a copy machine to the size shown on the right above. All the words, numbers, and images are the same on the two maps, it's just that everything is larger size on the enlarged map at right.

a. Would the bar scale, as shown on the newly enlarged map, still be accurate?

Yes.

Why? Please explain your rationale.

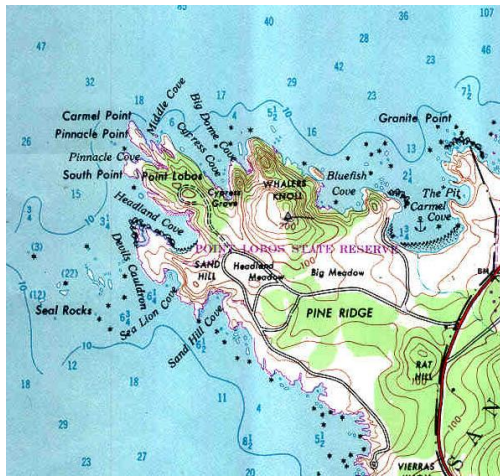
Because the bar scale was enlarged by the same proportion as the rest of the map.

b. Would the fractional scale, as shown on the newly enlarged map, still be accurate?

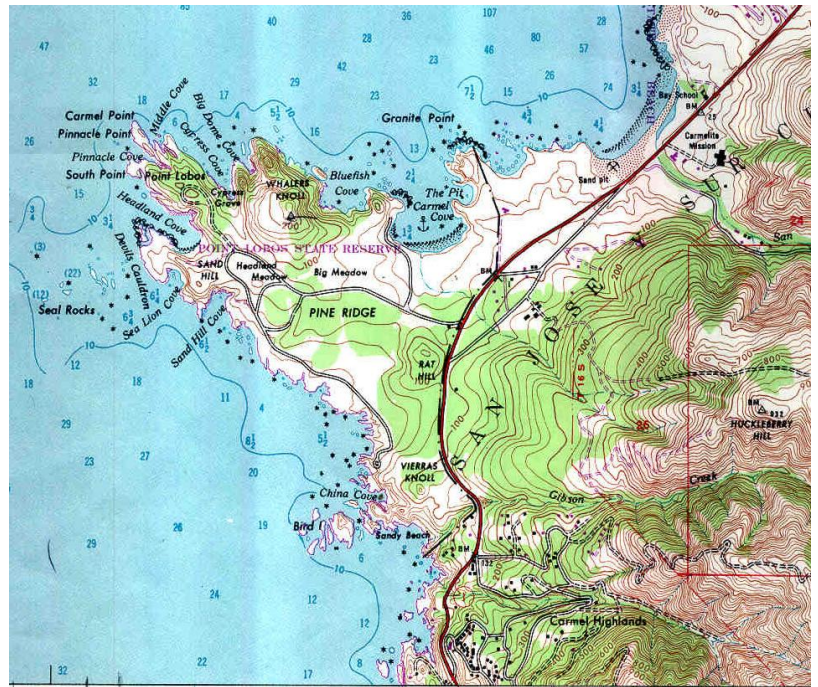
No.

Why? Please explain your rationale

The scale on the map has changed, but the numbers have not. Thus, the fractional scale on the enlarged map is not accurate.



Map A



Map B

6. Are Map A and Map B the same scale? Measure some features with a ruler to verify.
 The two maps are shown at the same scale.

Why? Please explain the rationale of your answer.
 The size of any object on the two maps is exactly the same size.

7. On the Monterey Bay Chart, how far is it, in nautical miles, from Pt Pinos to Pt Santa Cruz? Use the bar scale to estimate this distance.
 About 19 nautical miles

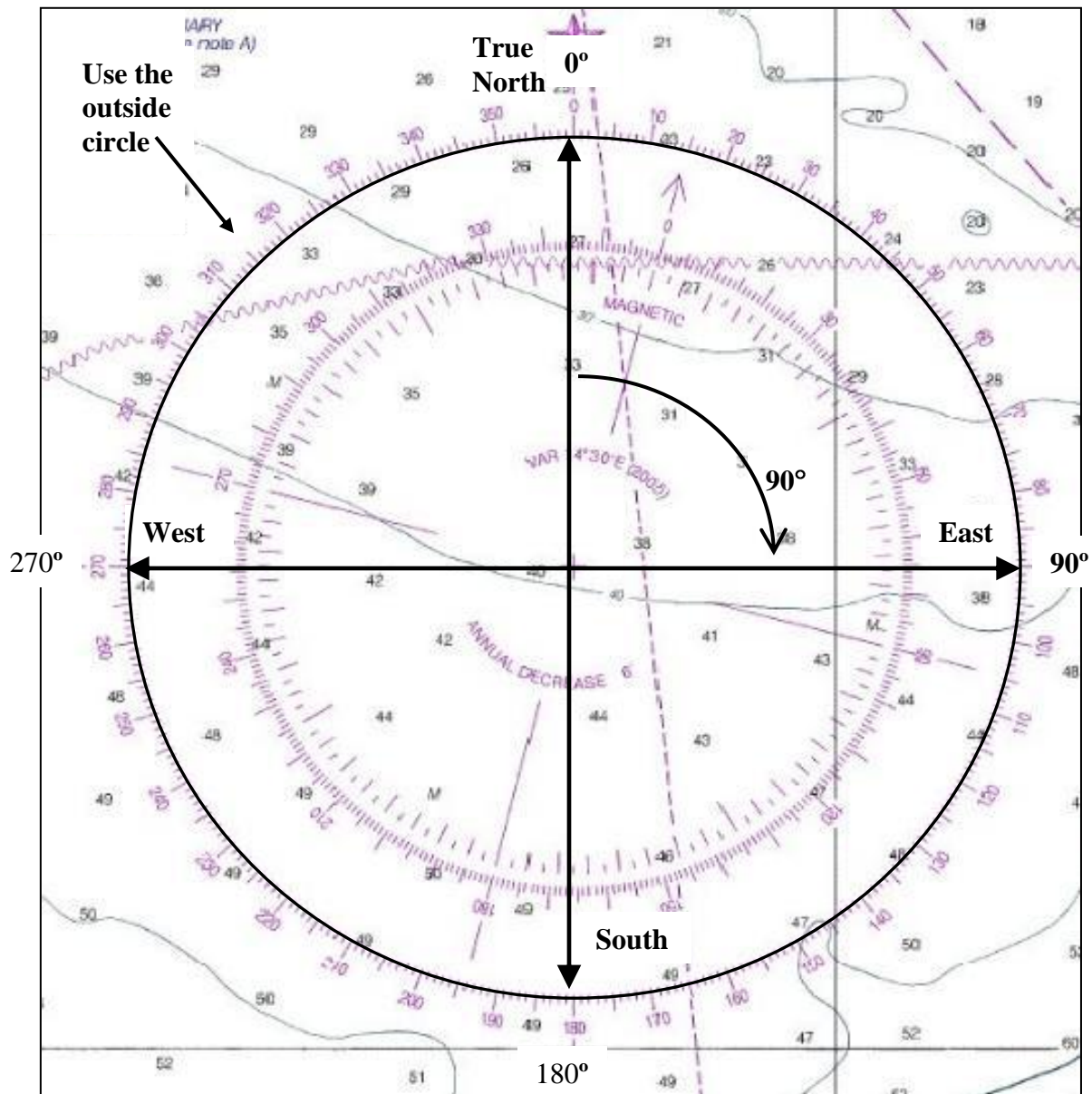
8. On the Monterey Bay Chart, how far is it, in nautical miles, from Pt Pinos to the mouth of the Salinas River?
 ~9.5-10 nautical miles

9. On the Monterey Bay Chart, how far is it, in yards, from the northernmost rocks of Pt Joe to the northernmost rocks of Pt Pinos?
 ~4000 yards

10. On the Monterey Bay chart, how far is it, in yards, from the tip of Municipal Wharf #1 to the tip of Municipal Wharf #2. Use the inset in the lower right corner of the chart for this question.
 ~250-275 yards

IV Direction (bearing)

In navigation, a particular direction is referred to as a **bearing**. Bearings are described as an angle measured in degrees clockwise from true north.



Compass rose diagram found on nautical charts. The compass rose is used to determine bearings. Always use the outside circle, with true north at the top, to determine bearings. A bearing of directly East, would be described as a bearing of 90° as shown on the image.

Example: What is the bearing from the Pt. Pinos lighthouse to the mouth of the Salinas River? (You should get about 42° for the answer here)

1. What is the bearing from Pt Santa Cruz to the stacks at Moss Landing?

126°

2. What is the bearing from the stacks at Moss Landing to Lovers Point?

210°

3. What is the bearing from Lovers Point to the stacks at Moss Landing?

30°