The Oceans: Monterey Bay, Metric Units and Charts

Name _____ TA & Section _____

Date _____

Conversion Table

1 fathom = 6 feet
100 fathoms = 1 cable length
10 cables length = 1 nautical mile
1 nautical mile = 1.151 statute miles (length of a minute of longitude at equator)
3 nautical miles = 1 league
1 knot = 1 nautical mile per hour = 1.151 statute miles per hour
10 chains = 1 furlong = 201.17 meters
60 nautical miles = 1 degree of a great circle of earth (latitude)
1 statute mile = 5280 feet
1 nautical mile = 6076.115 feet

The **Metric System** of weights and measurements is used worldwide. In most parts of the world, it is the only system. In the United States, it is used for all scientific work, and occasionally for consumer products as well. The system is based on the following units:

Unit of length: the meter (m)
Unit of mass or weights: the gram (g)
Unit of volume: the liter (L)
Unit of temperature: the Celsius degree (^{o}C)

Metric units are also commonly referred to as SI units, for *Système Internationale* (or International System, in French).

Note: Statute miles is what we know as miles and is a measurement of distance over land. Nautical miles is a measurement over water.

Origin of Nautical Terms—If you saw the movie "Master and Commander", you might remember some of these methods.

Fathom - Sailors use to throw a line into the water, wait until it hit the bottom, pull it back up, while measuring the length of the line from finger tip to finger tip. The arm span of an average sailor was 6 feet and was called a fathom.

Knot - Lines use to be thrown over the sides of ships to determine speed. Each line was divided into 47 ft. 3 in. sections and were called knots. The line was allowed to run over the ship's side while a 28-second glass was emptying itself. The length of the knot was derived from the proportion that one hour (3600 sec) is to 28 seconds as one mile (6076.115 ft.) is to the length of one knot (47 ft. 3 in.).

Though it is not part of the metric system, the **nautical mile** (nm) remains a commonly used unit of length for ocean-going crafts. It represents 1/60 of a degree latitude (also known as 1 minute of latitude). We often use the conversion that 1 knot is 1 nm/hour.

PART 1. Unit Conversions. In this class, we will frequently need to convert from one set of units to another. You might also see different units for the same thing (for example, knots versus miles per hour). This first assignment will give you some practice with conversions.

Questions:

1) How many feet are in a nautical mile? How many feet are in a meter?

2) How many feet are in a league? How many nautical miles in a league?

3) What is your height in feet and meters (you can use the meter sticks available in the classroom)?

4) Convert the deepest point in the ocean, the Marianas Trench at a depth of 35,802 feet, to fathoms, leagues, and meters.

5) The largest and fastest marine fish is the bluefin tuna weighing 1,500 pounds and swims up to 55 miles per hour. How fast is this in knots?

6) A typical research vessel travels at a top speed of 12 knots, while a fast ship, such as a ferry, often travels at speeds up to 30 knots. What are those speeds in miles per hour? How does this compare to a Bluefin tuna?

7) Convert 20,000 leagues to miles. Is it possible for such depths to occur in the ocean?

PART 2: Navigating Monterey Bay – latitude, longitude and bathymetry (work in groups of 2 or 3). List co-workers

For this exercise, we are going to get a little more familiar with where Monterey Bay is, and how we convert 3-dimensional data, such as the Earth, into 2-dimensional maps and charts.

Take a chart and the additional materials back to your lab bench. Please return the chart and materials to the station when you have finished. Answer the following questions – be sure to include a unit designation after all numbers that you write and show all your work!

Compare the "real" chart to the zoomed in region around Moss Landing, that is on the attached sheet. Can you find where the zoomed in region is on the large chart?

The depths given on the zoomed chart are in fathoms.
The scale for the zoomed chart is 1" = 0.74 miles.

1) What are the units for the depths on the large chart? What is the scale?
2) For depths between 0-200 fathoms draw isobathymetric lines every 20 fathoms (on the zoomed-in chart, NOT on the large chart). Two isobathymetric lines are given (for 3 fathoms and 10 fathoms) to help start you out. Beyond a depth of 200 fathoms, you may begin to draw your bathymetry lines every 50 fathoms.
3) On a separate piece of graphing paper, draw a depth profile from north-to-south along the transect line that is shown on the bathymetric map. On your x-axis, you should have the distance along the transect line (in miles). Along the y axis, you should have depth.

* Tip: An easy way to do this is to place the graph paper on which you will be drawing your depth profile on top of your bathymetry chart, taking care to line up the x-axis of your depth profile with the transect itself. As you travel along the transect line, make a tick mark wherever you cross a line of isobathymetry, and note the depth next to the tick mark. Once you have done this along the entire length of the transect line, you can return to your depth profile and plot the actual depths according to your y-axis. Don't forget to plot your profile as you move along the transect line from **north-to-south.**

To make your TA's very happy:

* Make sure that your isobathymetric lines do not touch. As you draw the lines in, remain aware of how many lines you will have to draw between depth readings! If you have a small space between very different depths, you will have to draw many lines through that little bit of space, so draw your lines accordingly.
* Try to keep your chart neat: this may mean drawing your isobathymetric lines lightly at first, then going over them again later. Erasing can make a chart look confusing quickly!
* On your depth profile, be sure to label both your x- and y-axis.

Questions:

4) What is the deepest point on the zoomed in chart? What is that depth in meters?
5) In those areas where you have isobathymetric lines drawn tightly together, is the change in depth steep or gradual?
6) Using the large chart, how deep (approximately) is Monterey Canyon?

To be turned in before you leave section:

List who was in your group.

_____ _____ _____

1) What are the units on the large chart _____ what is the scale on the large chart _____

2) Turn in at least one example (for your group) of the zoomed in chart with your isobathymetric lines (include all names on the sheet, please)

3) Turn in at least one example of your depth profile (include all names on the sheet, please)

4) The deepest point on the zoomed in chart is _____. That depth is _____ meters.

5) Is the change steep or gradual?_____

6) How deep is Monterey Canyon?_____

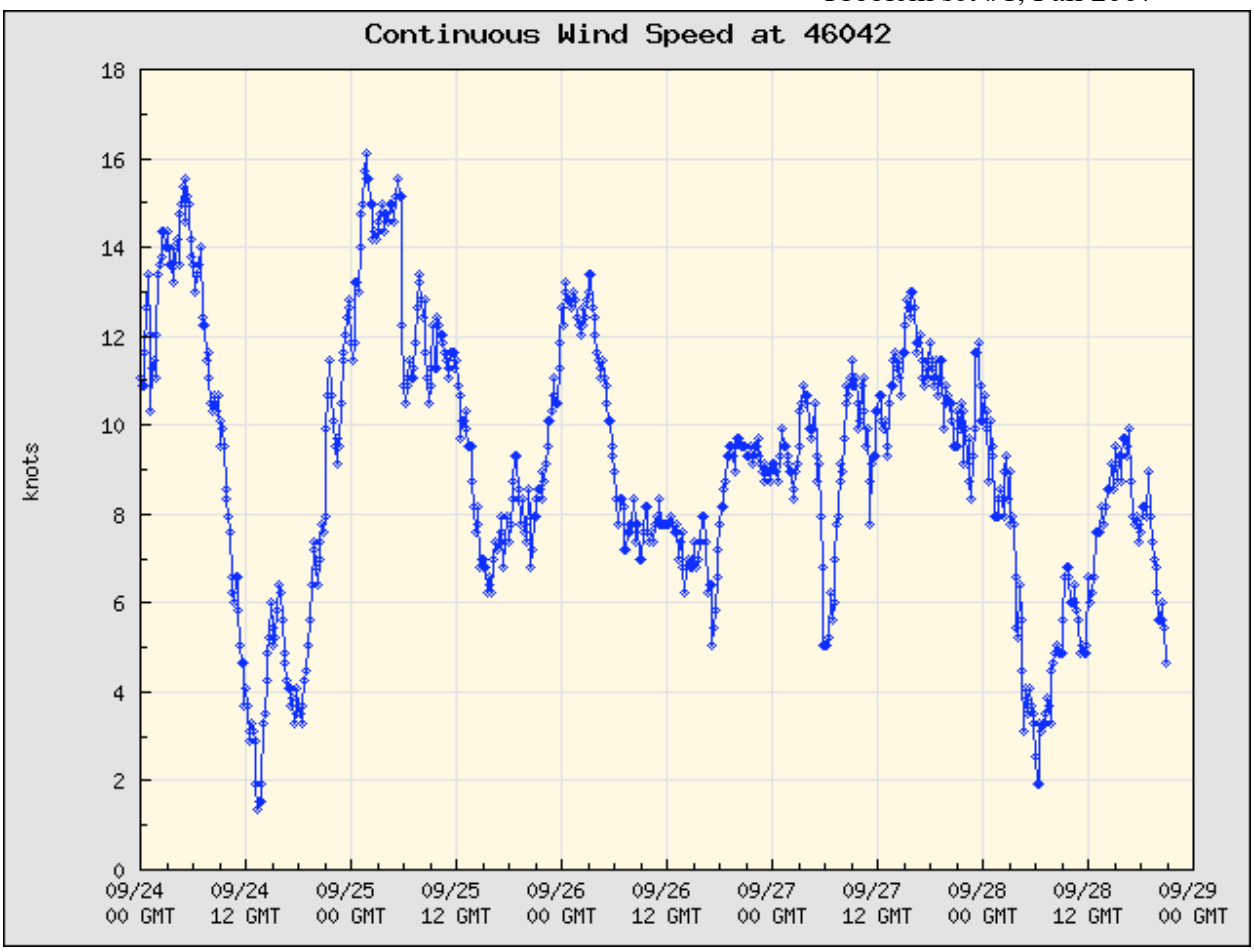

Sand Dunes
Bennett Slough
Elkh
Moss Landing
STACKS
Moss Landing
Moro Cojo Slough
Old Salinas River
Tembladero Slough
Mulligan Hill

PART 3: Presentation of data – Time series and contour maps (work independently—not due until the next section)

The National Oceanic and Atmospheric Administration (NOAA) operates the National Data Buoy Center (NDBC) which maintains a network of moored buoys along our coast and in the open ocean. Several instruments are mounted on each buoy to collect data for various oceanographic and atmospheric studies and improve weather forecasts. An example of a buoy is shown below. To answer question 1, you will need to go to the NDBC website at:

http://www.ndbc.noaa.gov/

1) Which NDBC buoy is located closest to Santa Cruz (make sure you are identifying the NDBC buoys, which are the blue squares)? _____



2) One way to represent data collected at such buoys is called a **time series**, in which a data set, such as temperature or salinity, is plotted versus time. A time series of wind speed at one buoy is shown above. In m/s, what was the maximum _____ and minimum _____ wind speed recorded at this buoy during the 5 days of the record? And when did they occur in local (Pacific) time? _____ (max) _____ (min)

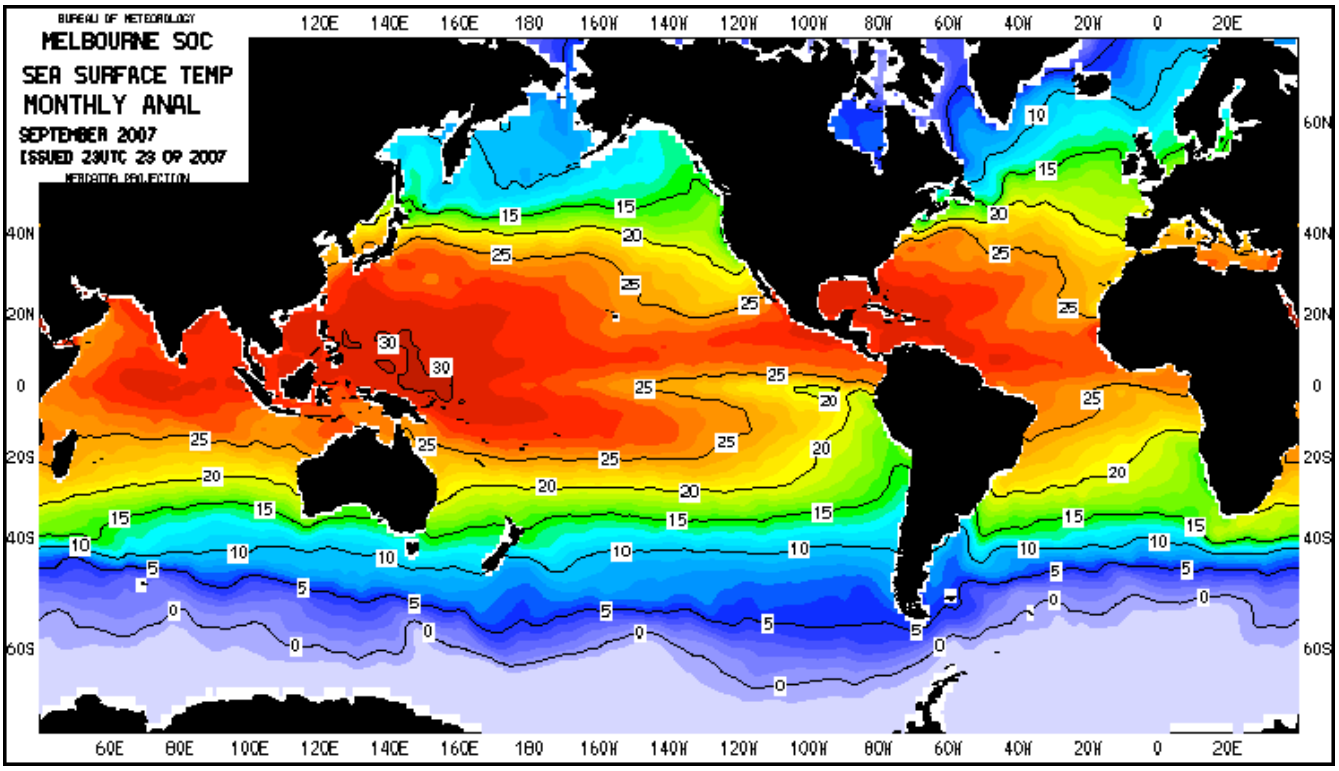
(Note that GMT stands for Greenwich Mean Time, and represents the time in Greenwich, England which is 7 hours ahead of us in Santa Cruz, so you'll have to convert from GMT to local time).

Roughly, what was the average wind speed recorded at the buoy? _____

Sometimes, data is collected along 2 spatial dimensions, and is presented in the form of a **contour map**. You have already used one example of such a map, of bathymetry, in Activity 2. But maps are also useful in presenting other forms of data. Here is an example of the average sea surface temperature (in ^{o}C) over the ocean for the month of November. Note that if you've printed these out in grayscale (rather than in color) dark shades correspond to both cold and warm temperatures. To get precise readings of temperature, use the contour intervals and notice that grayscale shades vary every 1 degree, which provides additional information.

NOTE: you can see the color version of the image at:

http://ic.ucsc.edu/~kudela/ocea1/images/latest.gif



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3) Approximately, what are the warmest _____ and coldest _____ temperatures shown and at what *latitudes* _____ (warm) _____ (cold) do they occur? At what *longitudes* do the warmest waters occur? _____

4) Approximately locate Santa Cruz on the map. Roughly what is the average temperature just off our coast here in September? _____ At the same latitude as Santa Cruz, what is the temperature on the east coast of the US? _____ What is the temperature off Baja, California? _____

5) Why do you think the sea surface temperature contours roughly follow lines of latitude? _____