This event covers the fields of physical and geological oceanography.

Resources are limited to a single sheet of paper 8.5x 11 inches and a calculator of any type.

No other student resources are permitted.

The test is 50 minutes in length.

DON'T PANIC!!!

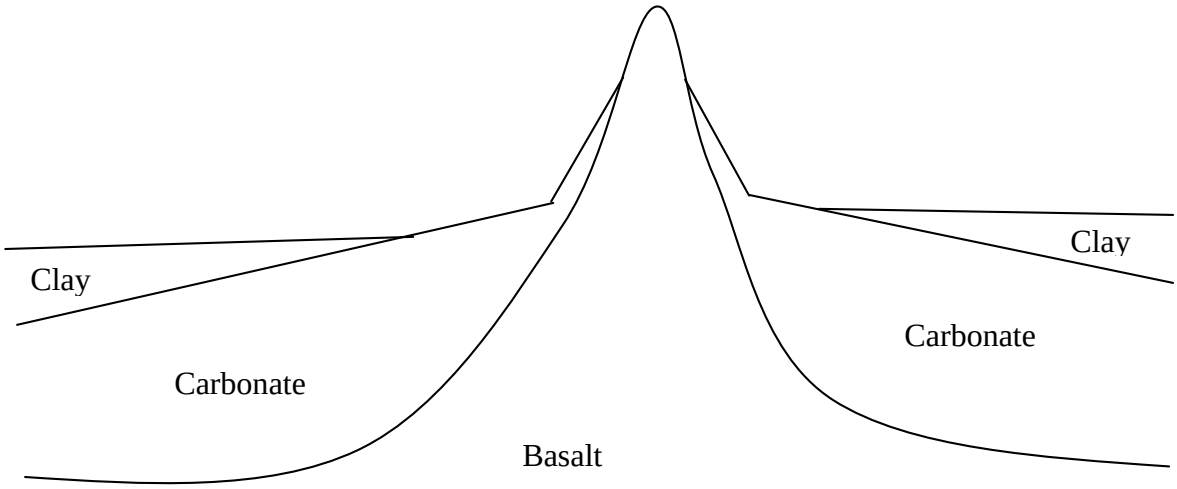
My tests tend to be very hard, with scores ranging from 20-80%.

Good luck!

For the answer key- a minimal acceptable answer is given in this font.

Italicized comments give additional information.

A. Sedimentary processes (32 points)



The plot above shows a schematic cross-section of the rock in the Atlantic. The following three questions are based on this plot. Explain

1. What sorts of particles make up carbonate sediments? (8 points)

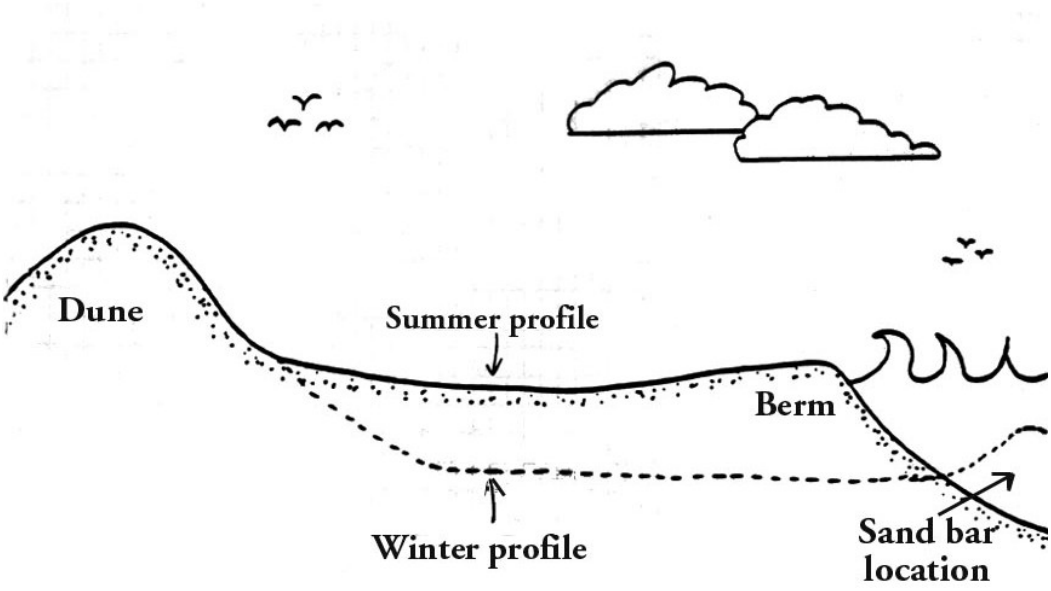
Carbonate sediments are usually composed of the shells of organisms that secrete calcium carbonate (chalk) such as coccolithophorids, foraminifera, and pteropods.

2. Why the blanket of sediment gets thicker as one moves away from the center of the plot. (8 points)

The center of the plot is a ridge associated with a spreading center. As the rock moves outwards from the spreading center it accumulates more sediments on top of it. In other words, the thicker blanket of sediment corresponds to older rocks.*(A number of teams put that the carbonate was heavier than the clay. Others that the sediments "slide down the slopes") The thing to remember here is that the vertical scale is hugely exaggerated, with ridge heights being a few km and ridge complex widths being hundreds of km, so the slope isn't actually that great.)*

3. Why carbonate sediments are covered up with clay at the edges of the plot. (8 points)

Below a certain depth (known as the calcium compensation depth or lysocline), calcium carbonate tends to dissolve. Once the ocean floor sinks deeper than this depth, carbonate material hitting the ocean bottom will dissolve, allowing clays to predominate.



4. The picture above show summer and winter beach profiles. Explain why these profiles are different. (8 points)

During the summertime, the waves are relatively gentle and tend to push sand towards the shore and building up a berm. During the wintertime, higher,steeper, waves tend to erode this berm and transport the sand offshore. (*To a large extent this mirrors the contrast between swell and sea waves. This picture won't be true if a hurricane hits the shore, but in most locations that's actually pretty rare.)*

B. Seawater and its properties (short answer, 3 points each)

1. Why is the sea salty (where does the salt come from)?

Most of it comes from rocks on land, which leach salt into runoff which eventually flows through rivers into the ocean. When water evaporates off the top of the ocean, the salt remains.

2. How is the pH of seawater likely to change as more carbon dioxide is put into the atmosphere?

Since carbon dioxide is a weak acid which dissolves in seawater, adding more of it to the oceans will result in increasing the acidity, causing the pH to go down.

3. Why does the apparent color of a fish change as it swims deeper into the water column?

Red light is prefentially absorbed by water- so that a fish that is red near the surface will appear bluer at depth.

4. How does a CTD sensor measure salinity?

By measuring the conductivity of the water.

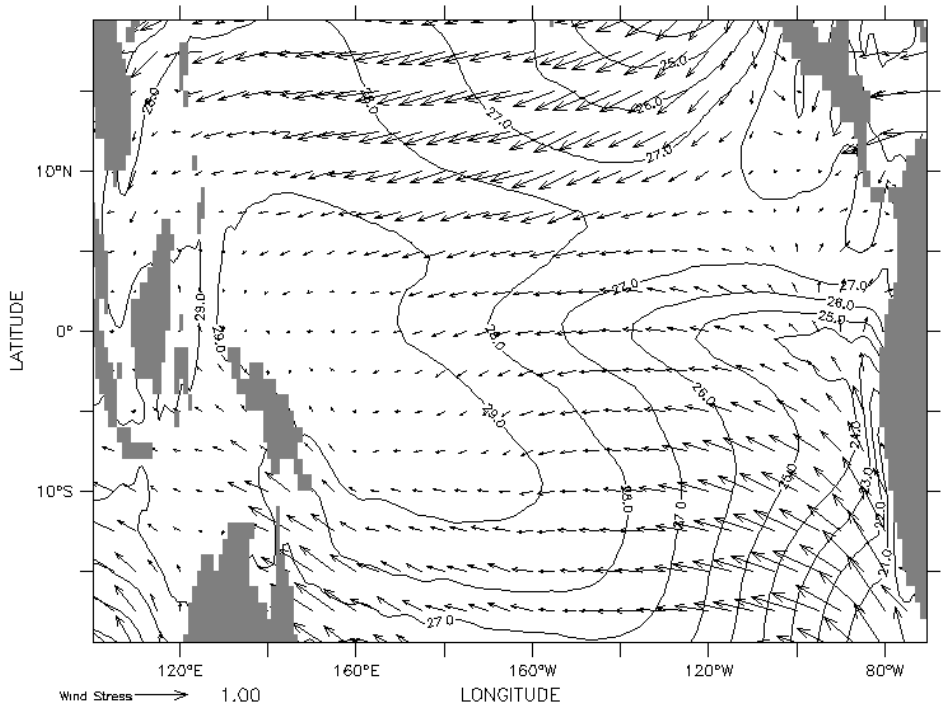
5. Why do oceanographers use potential temperature to look at the ocean?

Water temperature rises very slightly as the water is compressed under pressure (energy is added to it) as it moves down in the water column. This effect is reversed when the water expands as it moves up. Using potential temperature allows oceanographers to ignore this effect.

6. Name one major nutrient in seawater.

The three “major nutrients” are silicate, nitrate, and phosphate. (*Some people put iron, which is generally considered a micronutrient-though it is still very important. Others put calcium- which is not generally considered as a nutrient despite the fact that it’s used by calcifying organisms. For these I gave partial credit.)*

C. Physics of ocean circulation



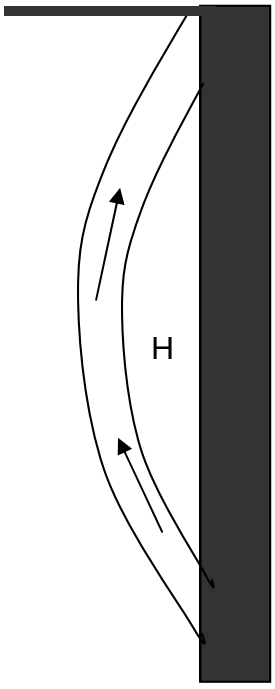
Sea Surface Temperature (Celsius_scale)

1. The plot above shows winds and sea surface temperatures along the equator. Why is the sea surface temperature coldest right along the equator? (10 points)

The easterly winds to the north of the equator result in a northward Ekman transport, while those to the south of the equator result in a southward Ekman transport. (5 points) This moves warm surface water away from the equator which is replaced by upwelling of colder subsurface waters. (5 points)

2. Would the Sverdrup transport be northward or southward at 8S, 160E? Why? (5 points)

The Sverdrup transport is southwards. The winds are pushing the waters in a clockwise direction, making the rotation more like that at the South Pole than at the North Pole. (*For more on Sverdrup transport, look at the presentation on the web page).*



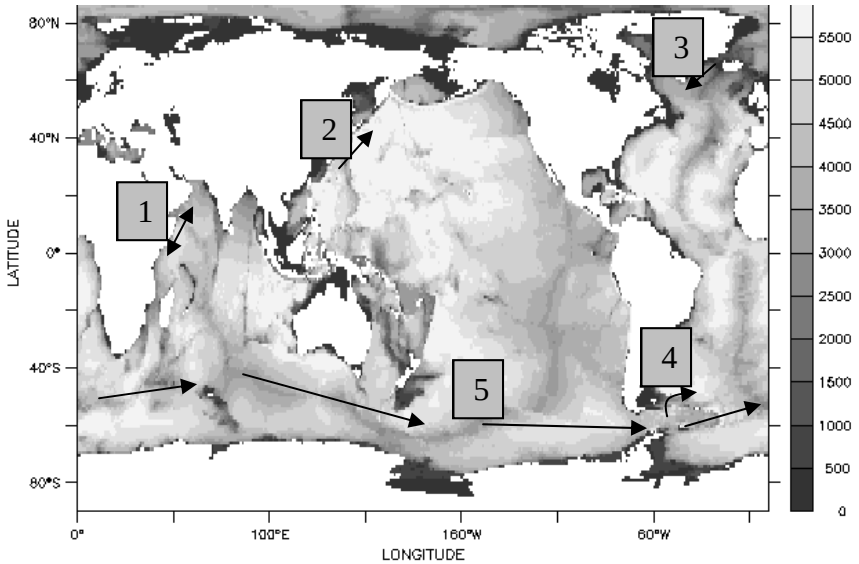
Suppose the moon has pulled a tidal bulge up against the edge of a continent in the northern hemisphere as shown at left.

3. A tidal bulge is not in geostrophic balance, but it is "trying" to come into geostrophic balance. Draw arrows showing the geostrophic flow associated with this high. (5 points)

4. How will the geostrophic flow cause the height of the bulge to change? (5 points) What does this tell you about how the earth's rotation explains the patterns of tides on earth? (5 points)

The geostrophic flow will move water from the back of the tidal bulge to the front of the bulge. This helps explain why tidal bulges propagates counterclockwise around amphidromic points in the northern hemisphere.

D. Current ID (10 points)



Ocean Depth

On the map above, draw arrows showing the location and direction of the following currents. 1. Somali 2. Kuroshio 3.East Greenland 4. Falklands 5. Antarctic Circumpolar

E. Fill in the blanks (10 points)

1. A ____deep-water_____ surface gravity wave has orbital motions that are essentially circular.

2. A ____shallow water_____ surface gravity wave has orbital motions that move essentially from side to side.

3. A _____guyot____ is a flat topped submarine hill more than 1.5 km in height.

4. Construction of a pier in the path of the longshore current will cause the beach to

___erode__ downcurrent of the pier. (*Look at http://www.csc.noaa.gov/beachnourishment/html/geo/images/a9f3.htm)*

5. _____El Nino_____ can be triggered by a burst of westerly winds along the equator in the western Pacific.

6. The __sea breeze___ is an atmospheric circulation that develops during the afternoons when the land warms up more than the ocean. (*Key point here is afternoon, sea breezes occur every day)*

7. The ___Antarctic Intermediate Water_____ is a water mass found in the Atlantic, Pacific, and Indian Oceans which is associated with a mid-depth minimum in salinity.

8. The ___Mediterranean Sea Water____ is a water mass found in the North Atlantic ocean that is associated with a mid-depth maximum in salinity.

9. A _____pycnocline____ is a region where there is a vertical gradient in density.

10. If a tide has a period of 12.4 hours, it is most likely caused by the __moon___.