Station 1: Tides

The following 5 questions refer to the Figure labeled "Monthly Tide Predications for May 2015"

1. On your answer sheet, label the spring tide(s) and neap tides(s) on the graph. (2 pts)

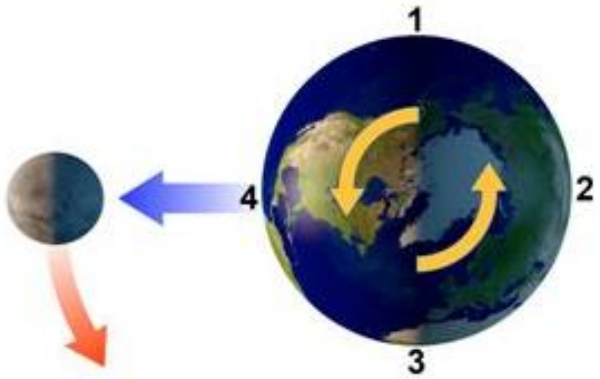
2. What was the phase of the moon on the 5th of the month? (1 pt)
   a. 1st quarter
   b. Full
   c. 3rd quarter
   d. Waning Crescent

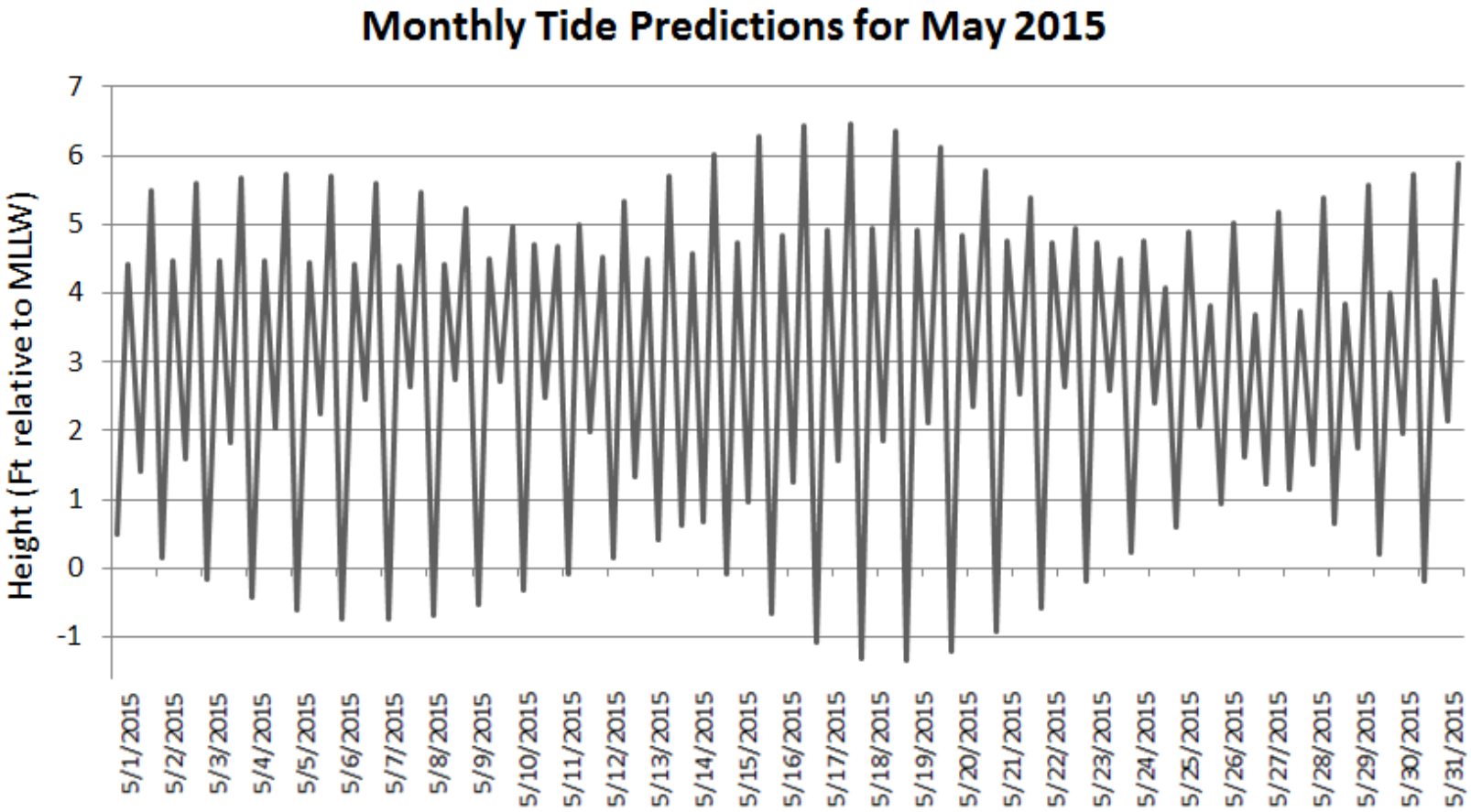
3. What is the phase of the moon on the 25th of the month? (1 pt)
   a. 1st quarter
   b. New
   c. Waxing Crescent
   d. 3rd quarter

4. What type of tides are experienced at this location? (1pt)
   a. Diurnal
   b. Semidiurnal
   c. Mixed Semidiurnal
   d. Annual

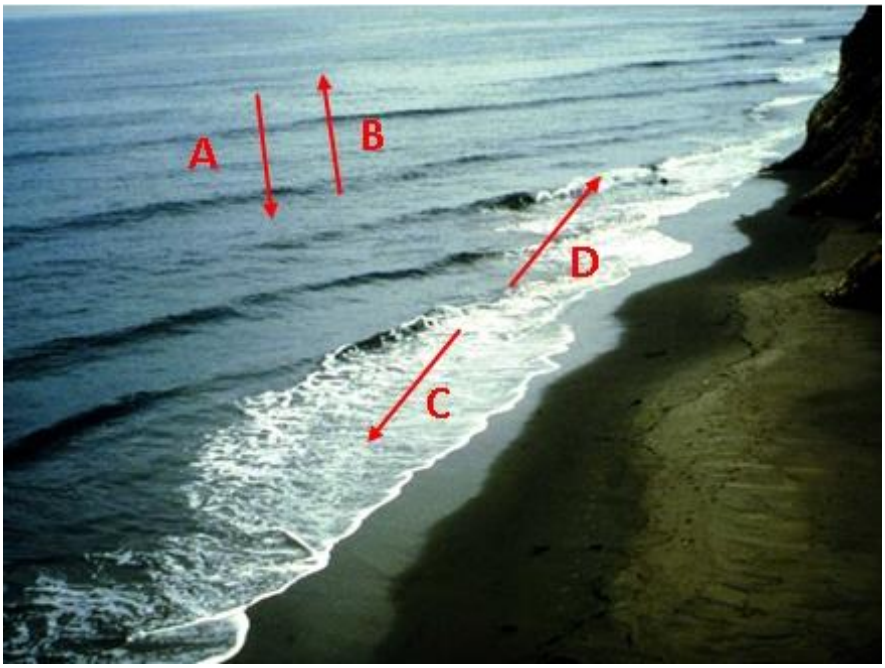
5. What is the most likely location for this tide predication? (1 pt)
   a. Bay of Fundy, Nova Scotia
   b. San Francisco, US
   c. Gulf of Mexico, US
   d. Hudson Bay, Canada

6. With the moon in the position shown below, which area(s) will experience low tide? (1 pt)




Monthly Tide Predictions for May 2015
Height (Ft relative to MLLW)
7
6
5
4
3
2
1
0
-1
5/1/2015
5/2/2015
5/3/2015
5/4/2015
5/5/2015
5/6/2015
5/7/2015
5/8/2015
5/9/2015
5/10/2015
5/11/2015
5/12/2015
5/13/2015
5/14/2015
5/15/2015
5/16/2015
5/17/2015
5/18/2015
5/19/2015
5/20/2015
5/21/2015
5/22/2015
5/23/2015
5/24/2015
5/25/2015
5/26/2015
5/27/2015
5/28/2015
5/29/2015
5/30/2015
5/31/2015

Station 1: Shoreline features and waves



7. What is the main direction of sediment transport in the image above? (1 pt)

8. What direction is the wind blowing in the image above? (1 pt)

9. What does the figure below tell us about sea level? (1 pt)

10. How did these features form? (1 pt)
    a. They are the remains of an eroded landslide toe.
    b. They are the eroded remains of the hanging wall of a coastal normal fault.
    c. They are fossil sea stacks on a marine terrace.

11. If the wavelength of a wave is 18 meters what is the wave base? (1 pt)
    a. 18 meters
    b. 9 meters
    c. 6 meters
    d. Not enough information provided

12. If waves are 3 times higher than normal during a storm. What is new wave base? (1 pt)
    a. 1.5 times deeper
    b. 3 times deeper
    c. 2 times deeper
    d. Not enough information provided

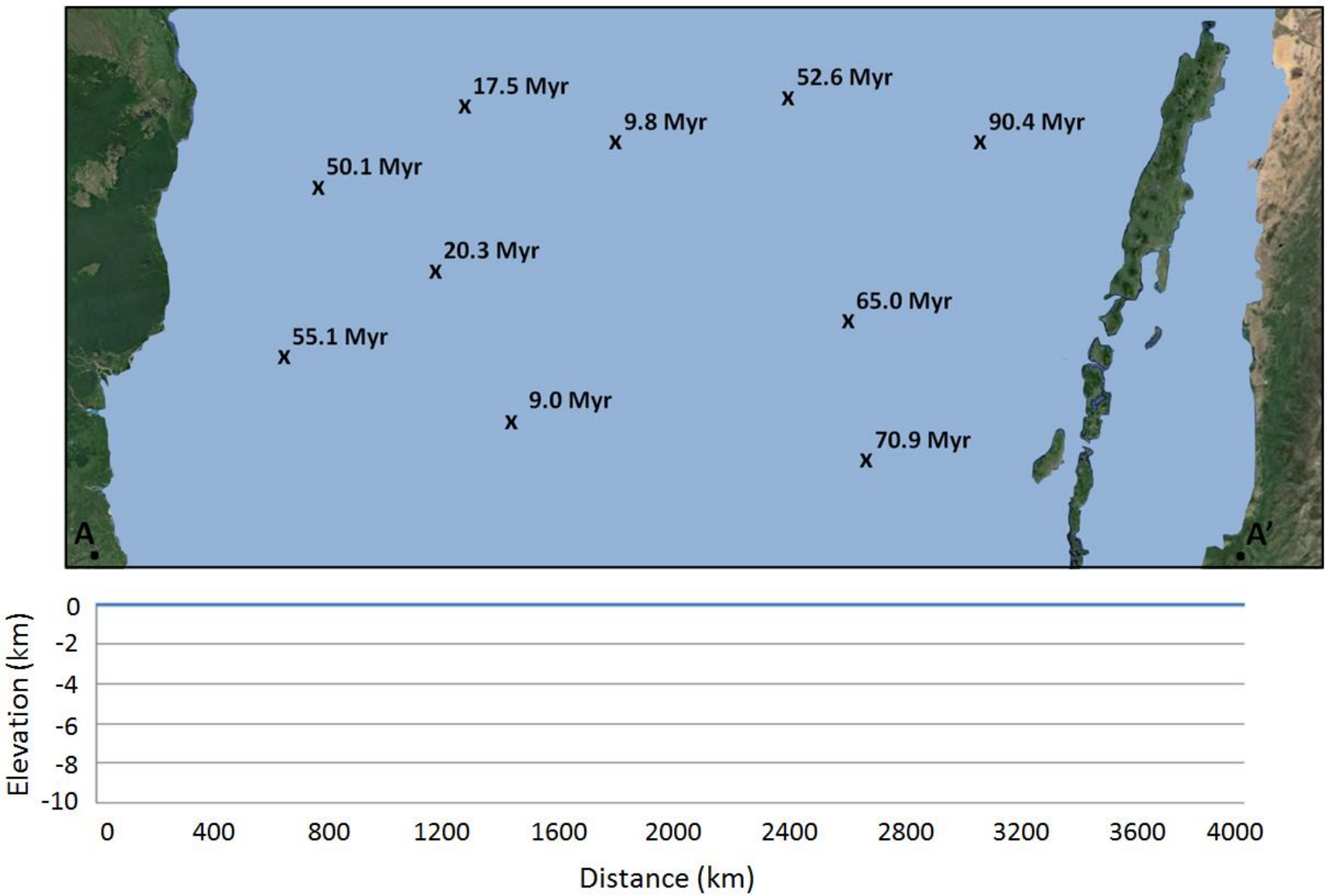
STATION 2

On the table a figure has been provided that shows two continents separated by an ocean. The numbers on the map indicate the age of the seafloor in millions of years.

1. On the map provided in your answer sheet, sketch the most likely location of a divergent plate boundary. (2 pts)

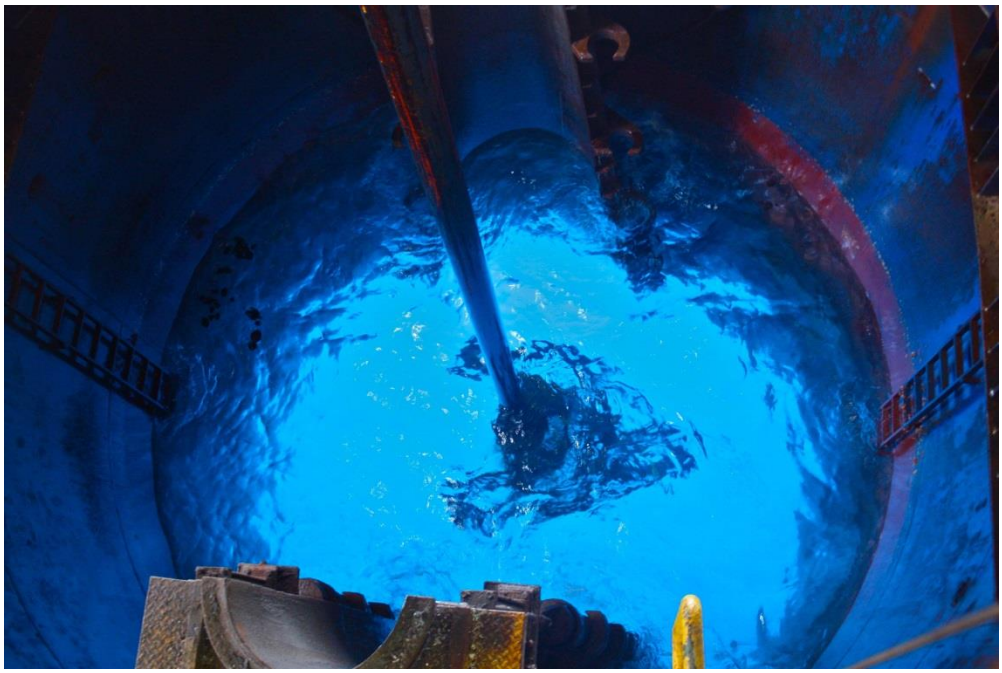
2. The coastline to the left is a passive continental margin. There is a convergent plate boundary along the eastern edge of the ocean. On the graph provided under the diagram, sketch the bathymetry from A to A' to scale. On your bathymetric profile, label any of the following features that apply: back-arc basin, continental shelf, mid-ocean ridge, abyssal plain, island arc, continental slope, trench, fore-arc basin, guyot.
   (8 pts)

3. How did the island chain form? (2 pts)


17.5 Myr
52.6 Myr
9.8 Myr
90.4 Myr
50.1 Myr
20.3 Myr
65.0 Myr
55.1 Myr
9.0 Myr
70.9 Myr
A
A'
Elevation (km)
0
-2
-4
-6
-8
-10
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
Distance (km)

Station 3

The JOIDES Resolution (Joint Oceanographic Institutions for Deep Earth Sampling) is a scientific drilling ship used to explore the sea floor. The drilling rig can be seen in the photo below. In the center of the ships is a hole or moon pool to allow the drilling equipment to go through ship to the sea floor. The second photo shows the moon pool. At this station you will explore ship displacement and determine how moon pools that are open to the air (like this one) affect the buoyancy of a ship.



Assume that you have a rectangular ship that is 140 meters long and 21 meters wide (similar in size to the JOIDES Resolution). This ship has a light ship displacement of 9450 st (short ton). The light displacement is defined as the weight of the ship excluding cargo, fuel, water, ballast, stores, passengers, and crew.

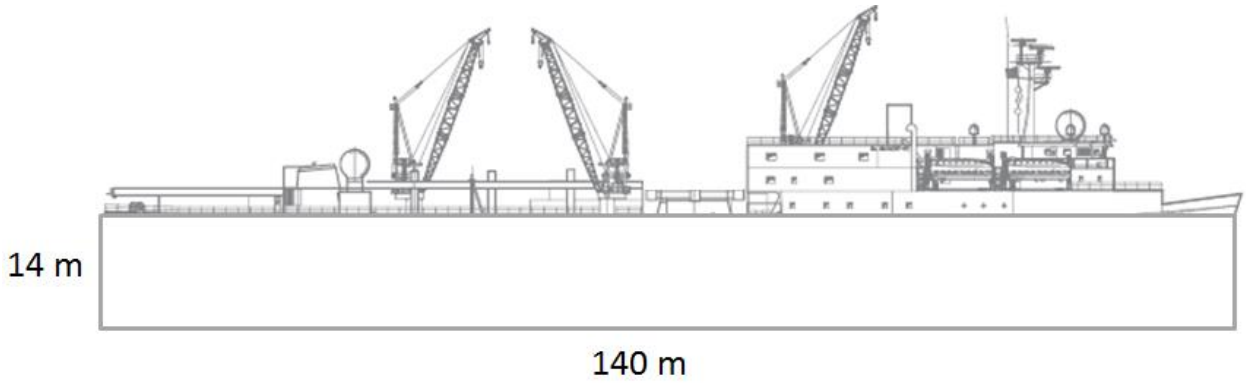
Useful information:

1 st = 2000 lb

1 N = 1 kg m/s^2 = 0.2248 lb

Density of seawater = 1025 kg/m^3

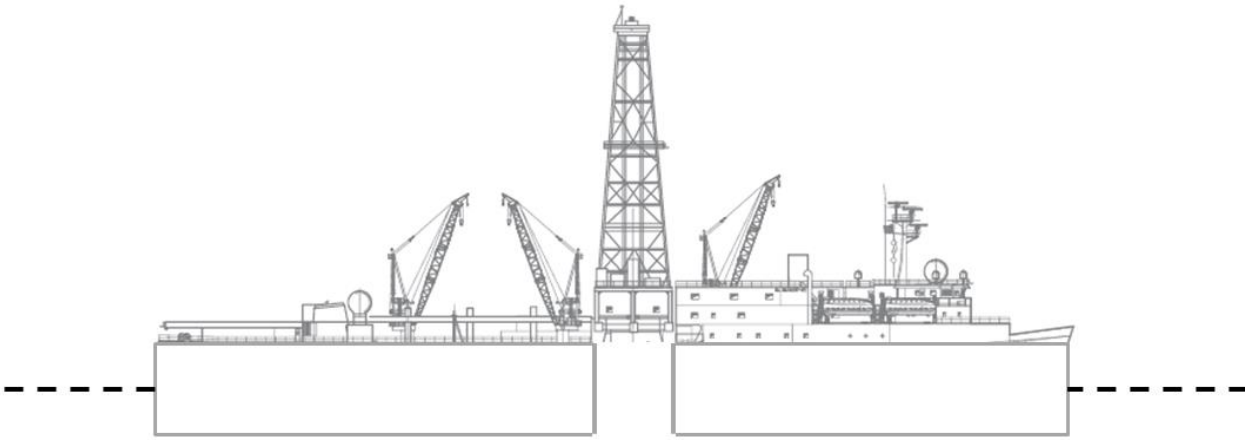
Draft = distance between vessel's waterline and the lowest point of the vessel



1. How low does the boat sit in the water? In other words, what is the draft of the ship? Show your calculations on your answer sheet. (5 pts)

2. What is the maximum weight of cargo that you can add to the boat without sinking it (i.e. when will the draft be greater than 14 m)? Show your calculations on your answer sheet. (5 pts)

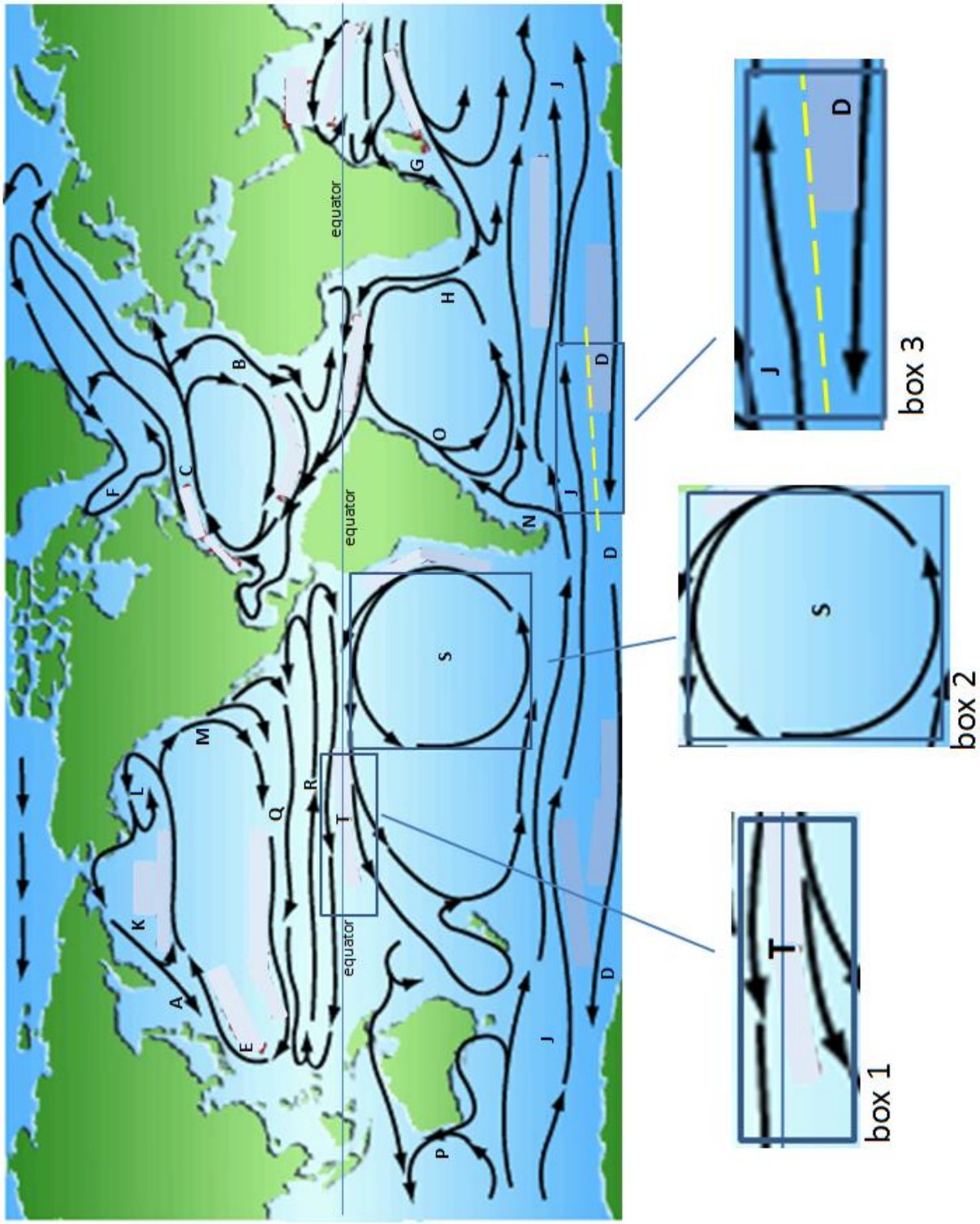
3. You want to modify the ship to accommodate a drill rig so you add a moon pool to the boat that is a 7 m wide cylinder. Assuming that the weight of the boat does not change, will the boat sit higher/lower/same in the water after the addition of the moon pool? (1 pt)



4. If the water level outside the boat is as shown by the dashed line, what would the water level in the moon pool be? Sketch the water level on the answer sheet. (1 pt)

Station 4.

The questions at this station refer to the figure below.



1. The area labeled ‘T’ in box 1 is a region of: (1 pt)
    a) oceanic upwelling
    b) oceanic downwelling
    c) convective overturn
    d) the Equatorial countercurrent
    e) low surface wind stress

2. The area labeled ‘T’ in box 1 is a region of: (1 pt)
    a) low nutrient availability
    b) high nutrient availability
    c) moderate nutrient availability

3. The main reason for the nutrient state of the area labeled ‘T’ in box 1 is: (1 pt)
    a) Ekman transport
    b) high Sverdrup throughflow
    c) the Coriolis Effect
    d) El Niño
    e) low levels of dissolved oxygen in these waters

4. The area labeled ‘S’ in box 2 is a region of: (1 pt)
    a) oceanic upwelling
    b) oceanic downwelling
    c) convective overturn
    d) the Equatorial countercurrent
    e) low surface wind stress

5. The area labeled ‘S’ in box 2 is a region of: (1 pt)
    a) low nutrient availability
    b) high nutrient availability
    c) moderate nutrient availability

6. The main reason for the nutrient state of the area labeled ‘S’ in box 2 is: (1 pt)
    a) Ekman transport
    b) high Sverdrup throughflow
    c) the Coriolis Effect
    d) El Niño
    e) low levels of dissolved oxygen in these waters

7. The name of this oceanographic feature at ‘S’ is the:_____ (write your answer in the space provided). (1 pt)

8. The major oceanographic feature located between the Antarctic Circumpolar Current ‘J’ and the East Wind Drift ‘D’ labeled in box 3, identified by the dashed line, is a region of: (1 pt)
    a) oceanic upwelling
    b) oceanic downwelling
    c) convective overturn
    d) the Equatorial countercurrent
    e) low surface wind stress

9. The dashed line in box 3 is a region of: (1 pt)
    a) low nutrient availability
    b) high nutrient availability
    c) moderate nutrient availability

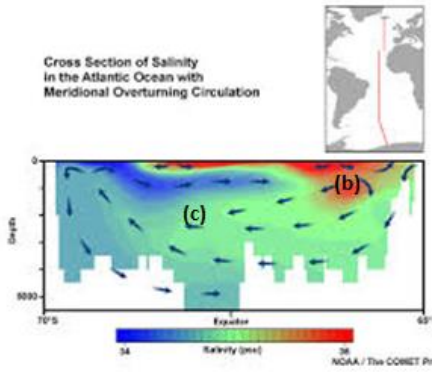
10. The main reason for the nutrient state of the area near the dashed line in box 3 is: (1 pt)
    a) Ekman transport
    b) high Sverdrup throughflow
    c) the Coriolis Effect
    d) El Niño
    e) low levels of dissolved oxygen in these waters

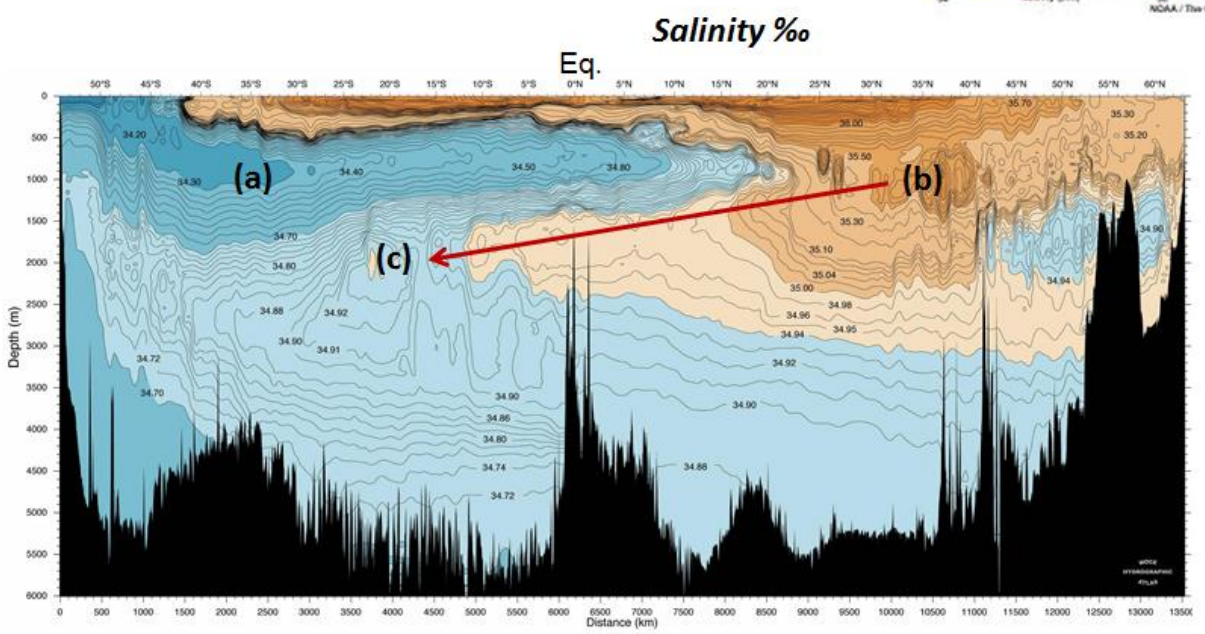
11. The name of the oceanographic feature represented by the dashed line in box 3 is the:_____ (write your answer in the space provided). (1 pt)

12. Which of the following currents is not a geostrophic current? (1 pt)
    a) Oyashio Current (labeled ‘A’ in the above figure)
    b) Gulf Stream (labeled ‘C’ in the above figure)
    c) Agulhas Current (labeled ‘G’ in the above figure)
    d) Kuroshio Current (labeled ‘E’ in the above figure)

Station 5.

Use the Figures 1 and 2 to answer the following Questions for this station. These are vertical profiles of salinity and temperature along North-South transects in the Atlantic Ocean (see location of profile in the upper right inset figure).





1. What is the salinity at point (a) and at point (b)? (1 pt)

2. What is the temperature at point (a) and at point (b)? (1 pt)

3. Points (a) and (b) are both located at 1000 meters water depth and at 35^{o} latitude away from the equator, to the south and north, respectively. In this question, please explain why the water at (a) and (b) would have different temperature and salinity values. Describe, in no more than 2 sentences, the source of these watermasses, and the oceanographic processes that produced the temperature and salinity values for (a) and for (b). (4 pts)

4. What is the name of the subsurface watermass (a)? (1 pt)

5. What is the name of the subsurface watermass (b)? (1 pt)

Note that circulation in the Atlantic Ocean would carry water from location (b) to location (c) (see inset circulation pathways). Use Figures 1, 2, and 3 to determine the change in density of a parcel of water as it travels from point (b) to point (c).

6. On Figure 3 on your answer sheet plot points (b) and (c) and record the change in density in the space provided. (2 pts)

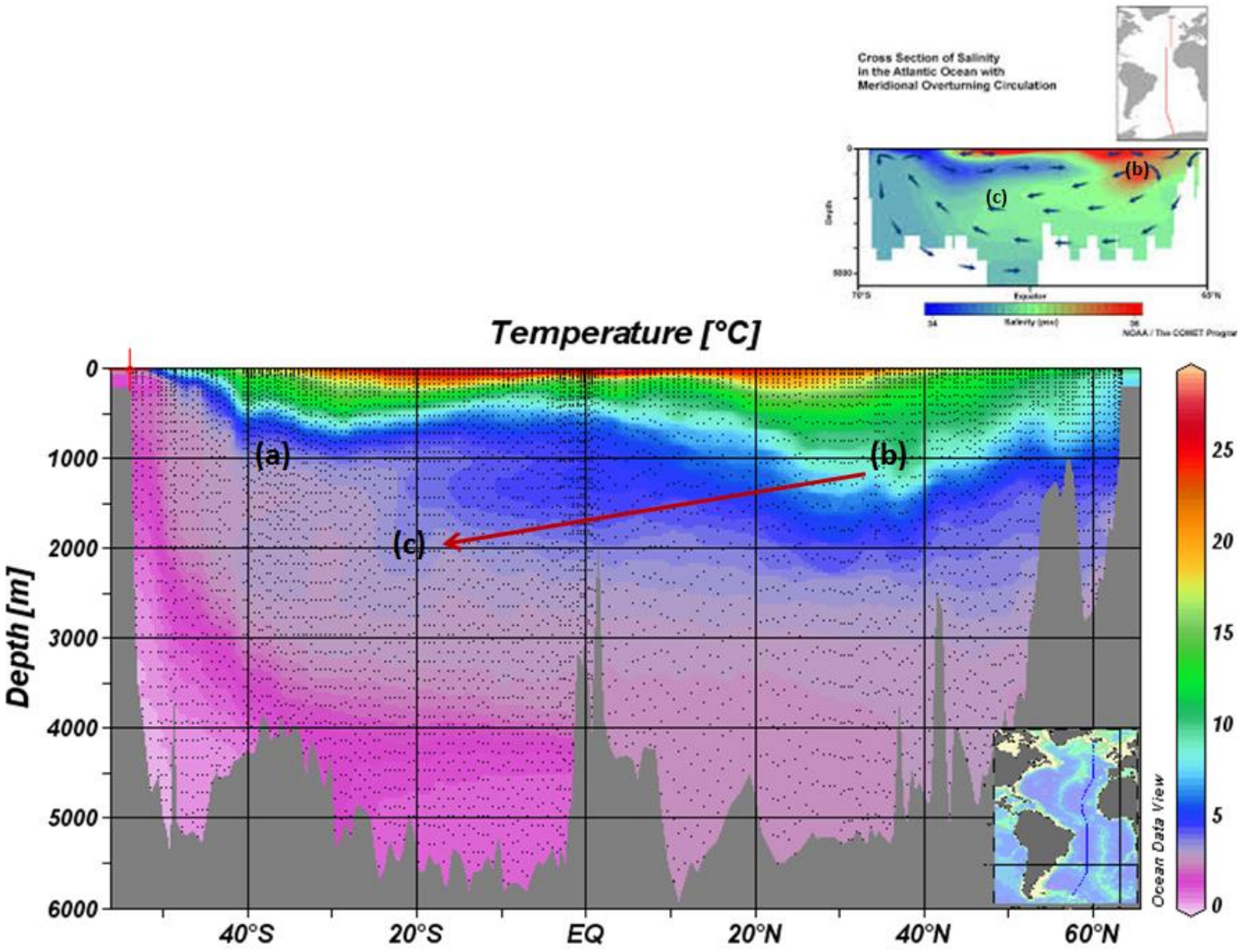


Figure 2

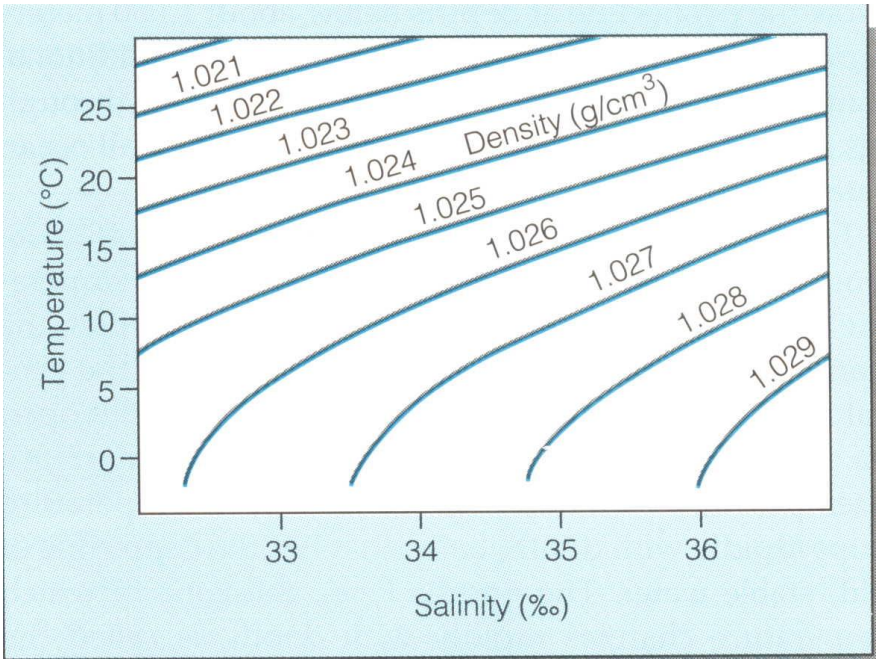
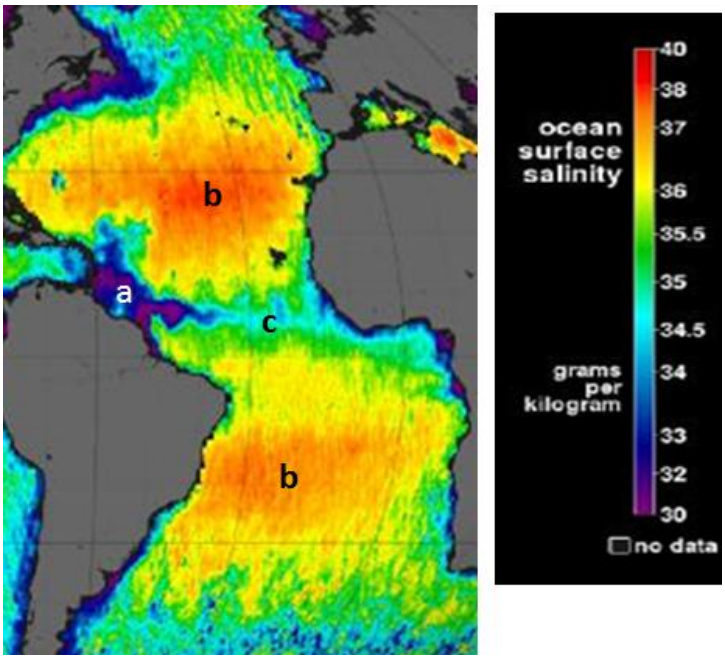


Figure 3

7. Write one sentence to explain the low salinity values at 'a' on the figure below. (1 pt)

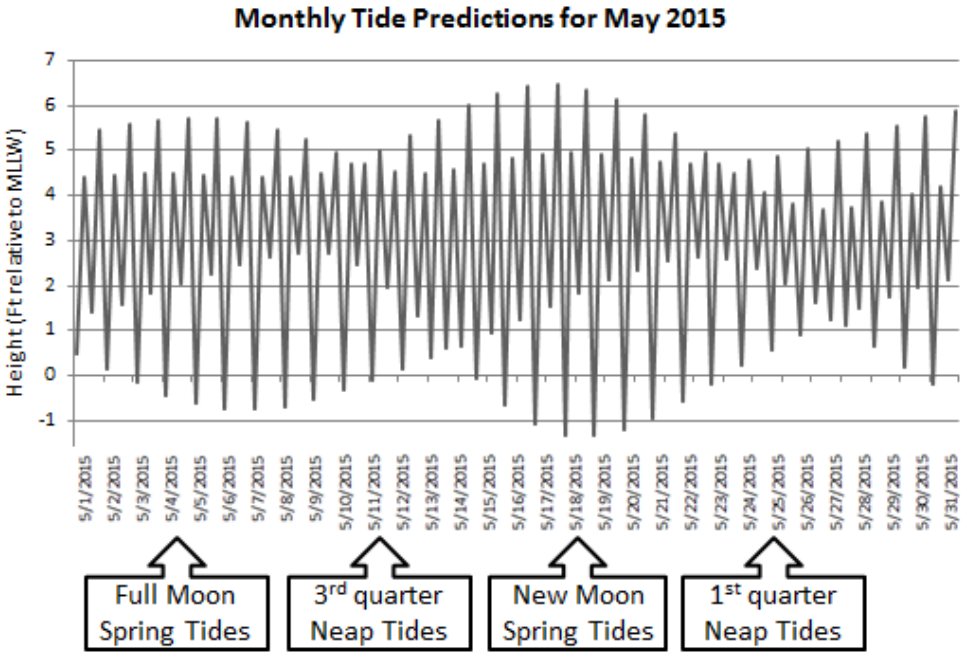
8. Write one sentence to explain the high salinity in two regions at 'b' on the figure below. (1 pt)

9. Write one sentence to explain the low salinity east-west zone near 'c' on the figure below. (1 pt)



Station 1.

1. Label spring and neap tides (2 pts)



2. b Full

3. a 1st quarter

4. c Mixed Semidiurnal

5. b San Francisco

6. 1 and 3

7. C

8. A

9. Sea level has fallen. It was once at the level of the grassy plains.

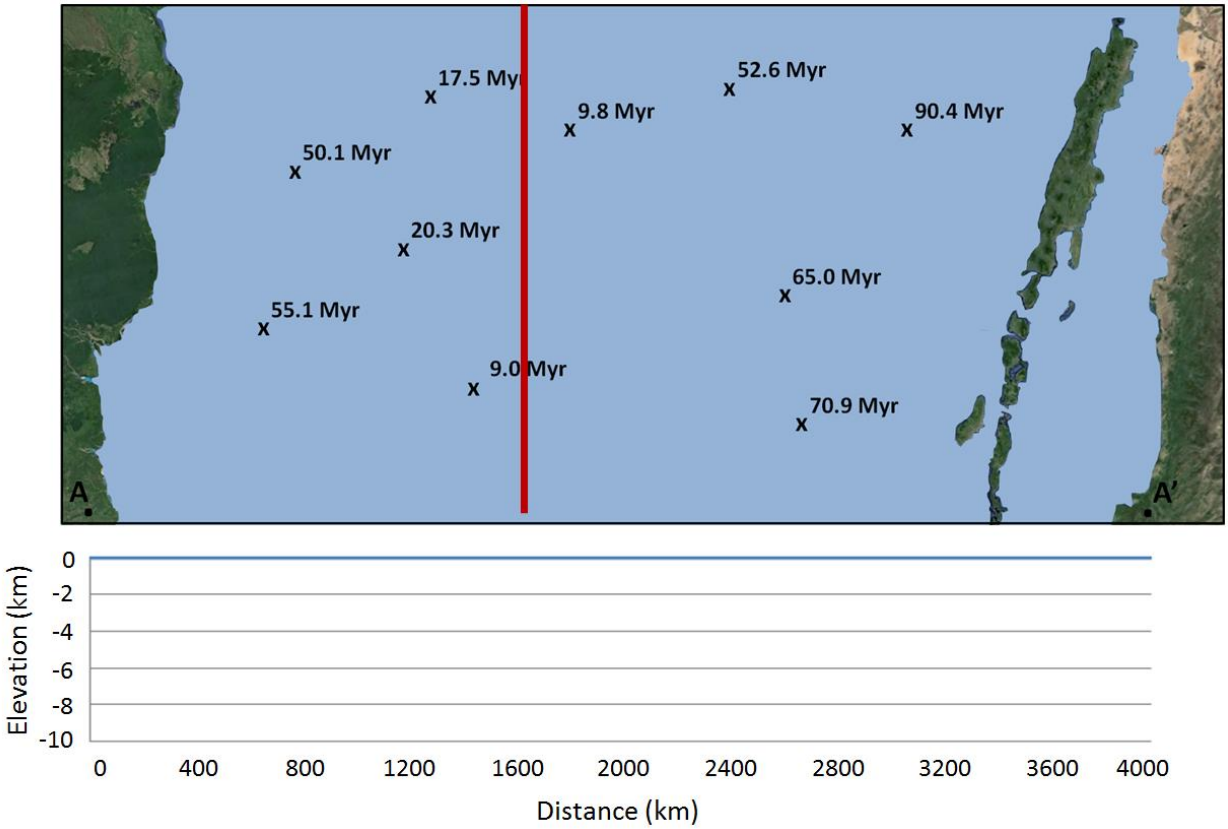
10. c They are fossil sea stacks on a marine terrace

11. b 9 meters

12. d Not enough information provided

Station 2.

1 & 2



4 pts on have the correct features in the correct locations (and labeled): trench, MOR, abyssal plain, continental shelf

4 pts on the accuracy of the depth of the features.

- Deepest trench = ~11,000; Wide of trench < 100km
- Continental shelf: average width = 80 km; depth <~150 m
- MOR; average depth = 2500 m (range from 0 to 4000 m)
- Abyssal plains: 3000-6000 m deep
- Backarch basin is shallow (similar to continental shelf in depth)

3. The oceanic plate is subducting beneath the islands. As it subducts, water is released causing melting in the overriding plate. The islands are a chain of volcanoes.

Station 3

1. Answer: ___2.8 meters

Displacement is the weight of water that a ship displaces when it is floating, which in turn is the weight of the ship. Displacement measures weight of a volume of water displaced.

Step 1: convert weight from st to Newtons

9450 st = 9450 st * 2000 lb/st = 18900000 lb (1 pt)

18900000 lb * 1N/0.2248 lb = 84074733 N (1 pt)

Step 3: F = (density of fluid)*(volume displaced)*(g) (3 pts)

84074733 N = (1025 kg/m3) * (140m*21m*H) * (9.81 m/s2)

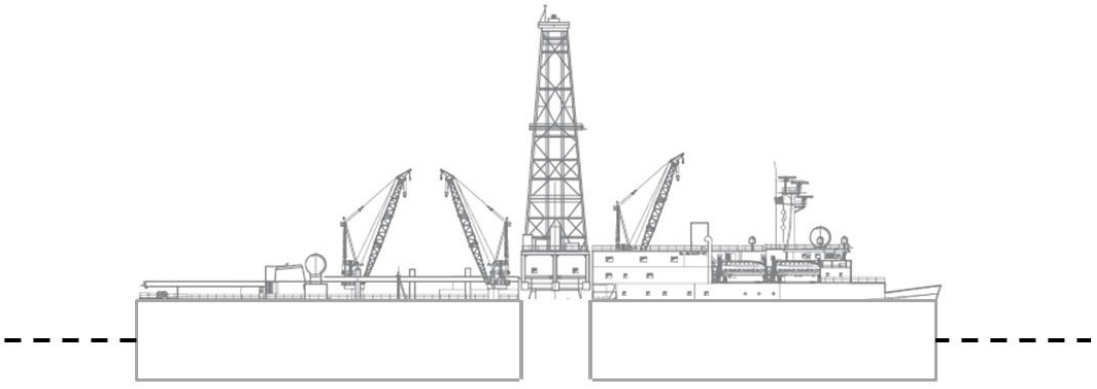
H = 84074733/1025/140/21/9.81 = 2.8 m

2. Answer: _37,069 st = 74,138,000 lbs = 329,795,370 N

Force = (1025 kg/m3)*(140*14*21)*(9.81 m/s2) = 413874090 N = 93938895 lb = 46519 st (2 pts)
Total weight – weight of ship = weight of cargo (2 pts)
46519 st – 9450 st = 37,069 st = 74,138,000 lbs = 329,795,370 N

3. Lower – because the surface area of the bottom of the boat is less so to displace the same volume of water the boat must sit lower in the water.

4. Same level as outside the boat



Station 4.

1. a oceanic upwelling
2. b High nutrient availability
3. c Coriolis Effect
4. b Oceanic Downwelling
5. a Low nutrient availability
6. c Coriolis Effect
7. South Pacific Gyre
8. a Oceanic upwelling
9. b high nutrient availability
10. c Coriolis Effect
11. Antarctic Divergence
12. A Oyahio Current (labeled A)

Station 5.

1a. 34.3‰ b. 35.5 to 35.7‰

2a. 4°C b. 9°C

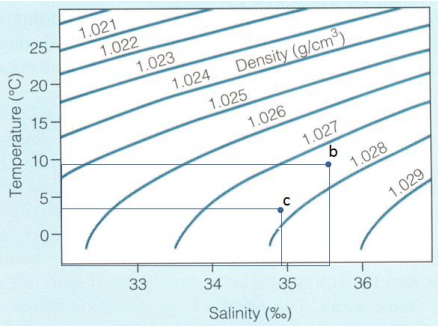
3. Watermass (a) is derived from surface waters in the Antarctic region and is influenced by melting of sea-ice, which decreases its salinity. This watermass sinks beneath warmer, less dense waters at the Antarctic Convergence.

Watermass (b) is derived from highly saline, and relatively warm waters flowing out of the Mediterranean Sea into the Atlantic Ocean via a deep-water outlet (~1000m). Evaporation in the Mediterranean Sea produces the high saline waters.

4. Antarctic Intermediate Water

5. Mediterranean outflow

6. 0.0002 to 0.0003



7. Amazon River outflow reduces surface water salinity and equatorial east to west currents keep water near the coast.

8. Areas of low precipitation and high evaporations due to dry descending air in the atmosphere.

9. Areas of high precipitation due to rising air releasing moisture as it rises and cools in the equatorial zone.

National Science Olympiad 2015

Dynamic Planet 'C'

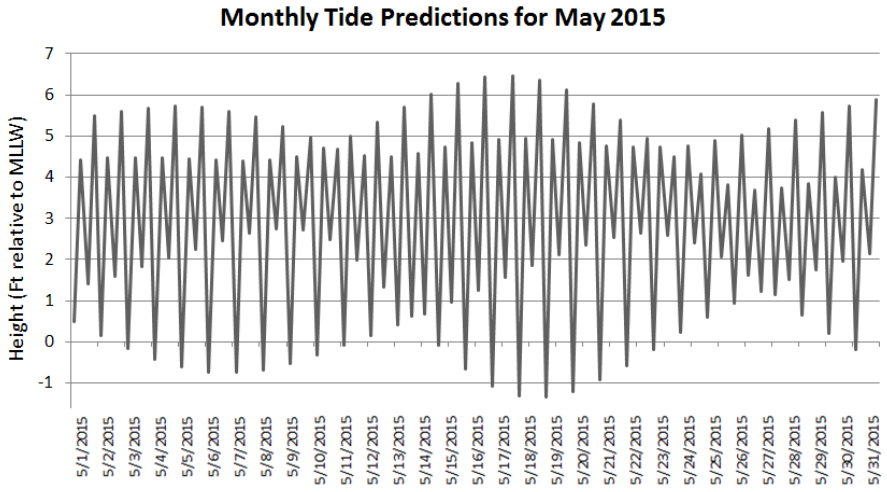
5/16/2015

School Name _____

Participant Names _____

Station 1.

1.



2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

_____

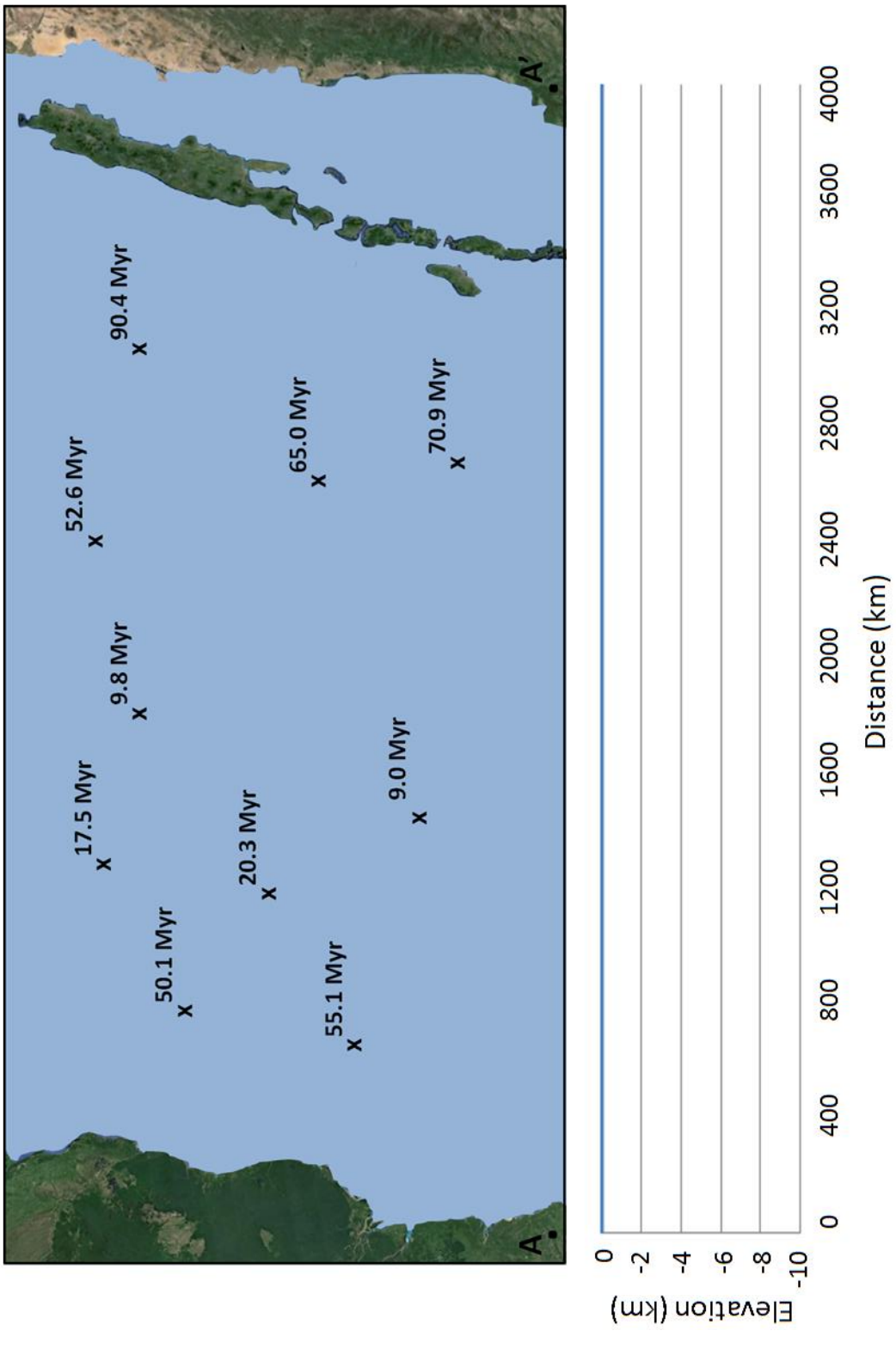
10. _____

11. _____

12. _____

Station 2.

1 & 2



3.

Station 3

1. Answer: _____

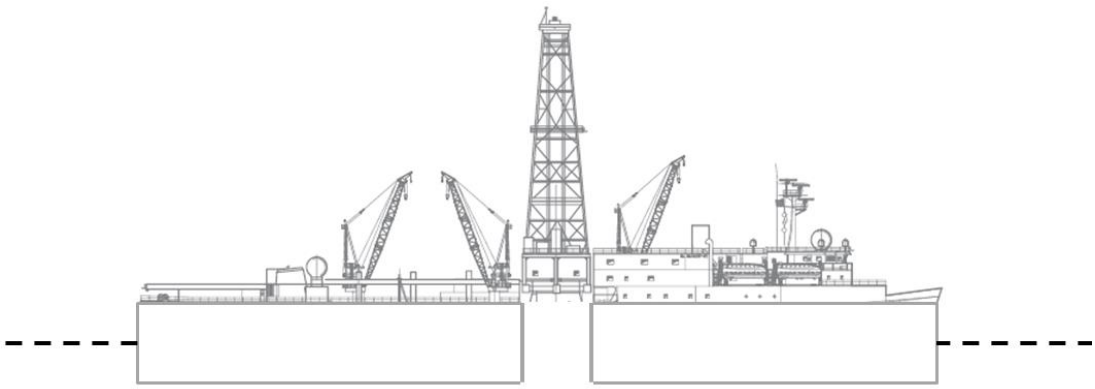
Work space

2. Answer: _____

Work space

3. _____

4.



Station 4.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Station 5.

1a. _____ b. _____

2a. _____ b. _____

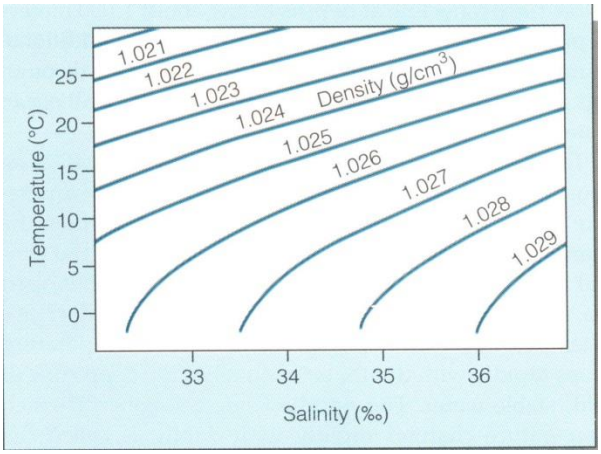
3. Watermass (a)

Watermass (b)

4. _____

5. _____

6. _____



7.

8.

9.