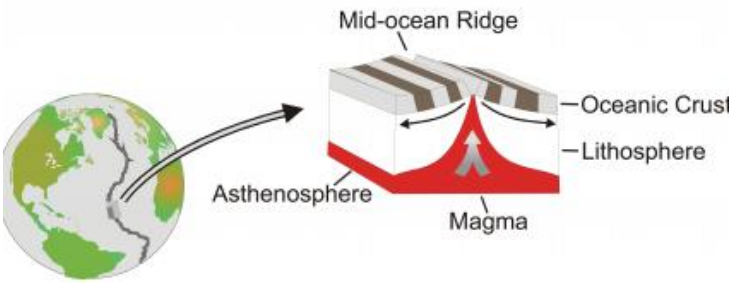
Name: _____ Date _____
Period _____

Dynamic Earth
Sea-Floor Spreading Lab

Introduction: According to the theory of plate tectonics (from the Greek, *tetko,* 'builder') the Earth's crust is broken into many slowly moving plates. *Sea Floor Spreading* occurs at the mid-ocean ridge where two plates are moving away from each other. Magma (hot molten underground rock material) rises up into the gap from below and cools to form new seafloor rock. Thus the sea floor spreads out to either side as show in Figure 1. This spreading occurs at about the same rate as your fingernails grow. In figure 1 the lithosphere is the outermost solid portion of the Earth, which includes the crust and part of the upper mantle, and asthenosphere is the rocky substratum below the lithosphere that is hot enough to be deformed and is capable of internal flow.

Figure 1



The pattern of sea floor spreading can be observed by studying the magnetic field of the rock on the sea floor. At the mid-ocean-ridge, magma rises up from the mantle below and cools. As it continues to cool, iron in the rock aligns itself with the magnetic field of the Earth, much like the needle in a compass. When rock solidifies, this magnetic 'signature' is locked in place.

Throughout history, the orientation of the Earth's magnetic field has varied greatly. At times, the magnetic pole in the north has reversed completely and was located near the south geographic pole. Because new ocean floor is constantly moving away from the mid-ocean ridge, these reversals appear as bands of alternating magnetic fields as shown on Figure 1. On average, the Earth's magnetic field reverses every several hundred thousand years with the most recent reversal occurring about 780,000 years ago.

Objective: Using ocean depth data you will construct an ocean bottom profile of the Atlantic Ocean. Using the profile, you will identify features of the ocean bottom in regions of diverging plate boundaries.

Procedure:

1. Construct an ocean bottom profile on graph paper using the data chart labeled North Atlantic Ocean Bottom Profile. Make an appropriate scale, and label the vertical axis 'Depth in Kilometers.' Once again, using an appropriate scale, label the horizontal axis 'Distance from U.S. coast in Kilometers.
2. **Once your graph is complete label the following features.**
   a. Mid-Atlantic Ridge b. Seamounts c. Continental Shelf
3. On your graph using a red colored pencil draw the direction of plate movement associated with the Mid-Atlantic Ridge. Next, with your red color pencil, draw the convection currents in the asthenosphere that cause the plates to pull apart.
4. With a blue color pencil shade the areas on your map where you would find the oldest age oceanic plate.

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by Mass	Percent by Volume	Percent by Volume	Percent by Volume
Oxygen (O)	46.40	94.04	33.0	21.0
Silicon (Si)	28.15	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.66	0.07	1.0	1.0

Data Chart:
North Atlantic Ocean Bottom Profile
(Depths are below sea-level; therefore you should start your graph with zero depth near the top of your page)
YOU MUST DO THIS BY HAND ON GRAPH PAPER—DO NOT USE A COMPUTER

DEPHT (KM)	DISTANCE (KM)
0	0
0.2	120
2.7	200
3.7	400
3.7	490
4.6	620
1.8	680
4.6	720
4.6	2000
4.0	2500
2.7	2900
1.8	3000
4.0	3050
2.4	3100
2.9	3200
3.5	3500
3.7	3600
3.7	3650
4.0	4025
2.7	4050
+0.5	4100
2.2	4125
4.6	4500
5.0	5000
4.4	5300
3.7	5800
2.7	6000
0.2	6075
0	6100

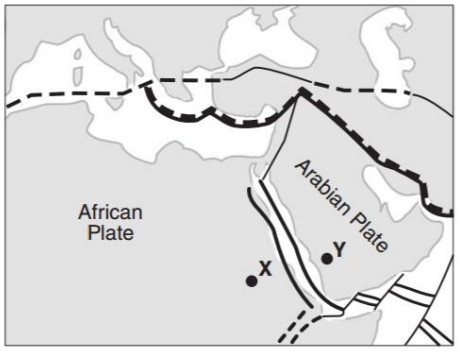
Questions: You MUST answer in a complete sentence or sentences on a separate sheet of paper for full credit!

1.) Explain two pieces of evidence that indicate that lithospheric plates move over Earth's surface?

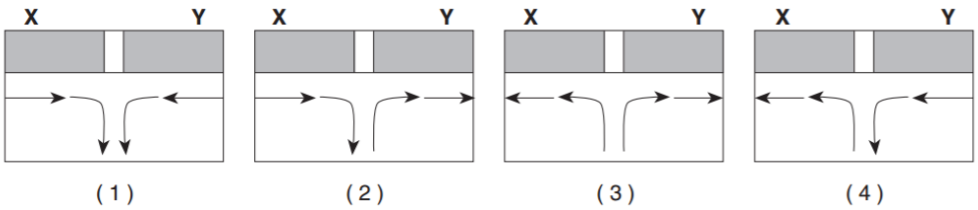
2.) How can plates move apart at the mid-ocean ridges and not leave a deep gap in the lithosphere?

3.) The rate of plate movement along portions of the Mid-Atlantic Ridge has been determined to be 3cm/year. At this rate how long will it take the Atlantic Ocean to widen another one kilometer? *Show **ALL** work or you will not earn credit*

The map to the right shows a portion of Earth's surface. Points X and Y are locations on the lithosphere.

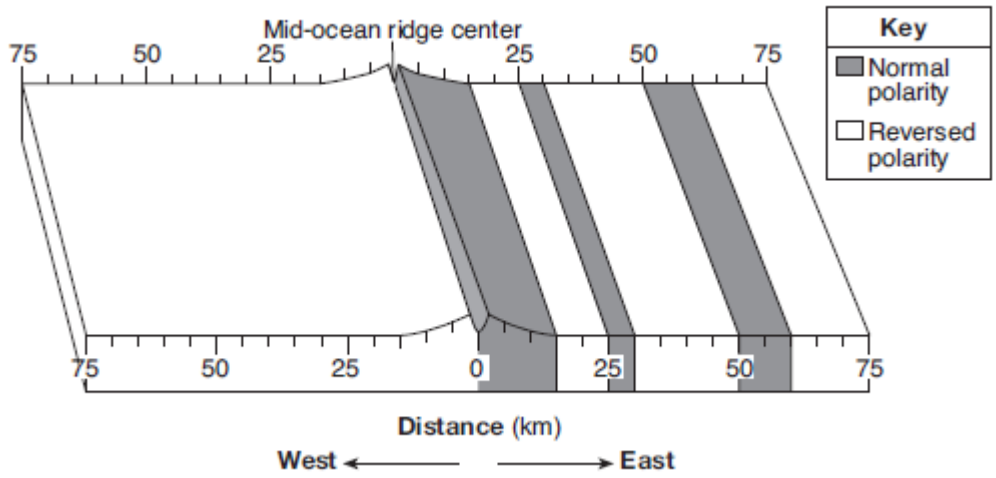


4.) Which cross section shows the inferred movement of material in the asthenosphere beneath points X and Y?



5.) Which two tectonic plates are separated by a mid-ocean ridge?
   a. Indian-Australian and Eurasian
   b. Indian-Australian and Pacific
   c. North American and South American
   d. North American and Eurasian

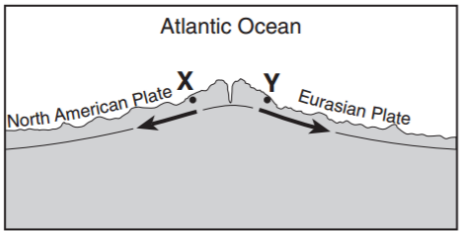
Base your answer to question 7 and 8 on the block diagram below and your knowledge of Earth science. The diagram represents the pattern of normal and reversed magnetic polarity of the seafloor bedrock on the east side of a mid-ocean ridge center. The magnetic polarity of the bedrock on the west side of the ridge has been omitted. Arrow represent the direction of seafloor movement on either side of the ridge.



6.) Complete the diagram by shading the pattern of normal polarity on the west side of the ridge center. Assume the rate of plate movement was constant on both sides of the ridge center. Your answer must show the correct width and placement of each normal polarity section

7.) Describe the general relationship between the distance from the ridge center and the age of the seafloor bedrock.

Base your answers to question 9 on the cross section below, which shows an underwater mountain range in the Atlantic Ocean. The oceanic bedrock is composed mainly of basalt. Points X and Y are locations in the bedrock that have been diverging at the same rate. The movement of the North American Plate and Eurasian Plate is shown by the two arrows.



(Not drawn to scale)

8.) Which statements best describe the age and magnetic orientation of the basalts found at locations X and Y?

a. The basalt at location X is younget than the basalt at location Y. Both locations have the same magnetic orientation
b. The basalts at location X and Y are the same age. Both locations have the same magnetic orientation.
c. The basalts at locations X and Y are the same age. Location X has normal magnetic orientation and location Y has reversed magnetic orientation
d. The basalt at location X is older than the basalt at location Y. Location X has reversed magnetic orientation and location Y has normal magnetic orientation.