Name _____ Date _____
Lab Grade _____/10 Period _____

Lab # _____ - Wind Driven Ocean Circulation and Ocean Gyres

Background Information:

Earth's oceans and atmosphere are inextricably linked. The ocean impacts the atmosphere and the atmosphere impacts the ocean through the exchange of matter and energy. One example of the close ties between atmosphere and ocean is the maintenance of ocean gyres; nearly circular wind-driven surface circulations centered at about 30° N and S in ocean basins. The frictional effects of prevailing winds on the ocean surface and Earth's rotation initiate ocean gyres.

Objective:

- Compare gyres of the northern and southern hemisphere
- List factors that are responsible for the formation ocean gyres

Materials: ESRT and Transparencies 1, 2 and 3

Time: 1 Period

Vocabulary:

Prevailing winds:

Ekman transport:

Ocean gyre:

Procedure:

PART A – NORTH ATLANTIC OCEAN

1. Hook the hole in transparency #1 over the nozzle of the globe. Make sure you can read "NH" on transparency #1 (not "SH"). Allow transparency #1 to lie along the globe towards the equator. The arrows on transparency #1 represent prevailing winds.

2. The winds shown on transparency #1 are also in the ESRT. Open the ESRT to the "Planetary Wind and Moisture Belts in the Troposphere". Place transparency #1 over the east coast of North America. According to the ESRT, what prevailing wind does the long arrow in the mid-latitudes represent?

3. According to the ESRT, what prevailing wind does the long arrow in the tropical region represent?

4. According to the ESRT, what prevailing wind does the long arrow in the polar region represent?

5. Move transparency #1 from the east coast of North America eastward across the Atlantic Ocean to help visualize the wind belts.

6. The friction of air blowing across the ocean surface pushes the water forward. Moving over the rotating Earth, the water pushed by the wind is deflected to the _____ in the Northern Hemisphere,

7. The direction of Ekman transport is represented on transparency #1 by broad arrows with the symbol _____ inside the arrow.

8. Again move transparency #1 eastward across the Atlantic Ocean. In the prevailing westerlies, the winds are driven from the _____ to the _____ and the Ekman transport of water is to the _____.

9. Again move transparency #1 eastward across the Atlantic Ocean. In the northeast trade winds, the winds are driven from the _____ to the _____ and the Ekman transport of water is to the _____.

10. Remove transparency #1 from the globe. Place transparency #2 along 30°N in the Atlantic Ocean. Be sure you can read "NH" (not "SH"). Place a piece of tape to temporarily stick the transparency to the globe. The arrows represent the Ekman transport of water with the symbol _____ in the arrows.

11. Ekman transport for the prevailing westerlies and northeast trade winds move water (toward, away from) 30°N (approximately the center of the Atlantic Ocean).

12. Along the western margin of the Atlantic Ocean, the North American coastline forces surface water northward. Along the eastern margin of the Atlantic Ocean, the European and West African coasts, force surface water southward. The net effect of the coastline and the Ekman transport of the Prevailing Westerlies and Northeast Trade Winds is the (depression, mounding) of the sea surface in the mid-Atlantic at 30°N.

13. Use a marker to indicate, "H" (high) or "L" (low) in the open circle of transparency #2 to identify the topographical relief of the ocean surface.

14. Remove transparency #2.

15. So far we have seen that the wind belts help produce a mounding of water. Think of the mounded water as water on a hill. Water on a hill is pulled down by _____. If the Earth did not rotate, then the water would flow straight down hill as shown in the next diagram.

Non-Rotating
Earth
(Top View)

16. The Earth does rotate counterclockwise _____°/hour.

17. Place transparency #3 over 30°N. The letter you drew with the marker should be at the center of transparency #3. Be sure you can read "NH" (not "SH"). Place a piece of tape to temporarily stick the transparency to the globe.

18. The curved arrows show the flow of surface waters. As the surface water flows "downhill", the motion of the water is deflected to the _____ by Earth's rotation (the Coriolis effect).

19. The overall pattern of the flow around the mound of the Atlantic Ocean water centered at about 30°N (as seen from above) is (clockwise, counterclockwise). This is the North Atlantic subtropical gyre.

20. **The gyre arises because winds and Earth's rotation create a _____ of water and then gravity and Earth's rotation combine to give water running downhill a twist to the _____ in the northern hemisphere.**

PART B – NORTH PACIFIC OCEAN

21. Now place transparency #1 in the middle of the Pacific Ocean. Be sure you can read "NH" (not "SH").

22. There is a (depression, mounding) of water in the North Pacific Ocean.

23. Take off transparency #1. Place transparency #2 at 30°N on the globe with a piece of tape.

24. With a marker, write "H" or "L" in the center of transparency #2.

25. Take off transparency #2. Place transparency #3 at 30°N on the globe with a piece of tape.

26. The curved arrows show the flow of surface waters. As the surface water flows "downhill", the motion of the water is deflected to the _____ by Earth's rotation (the Coriolis effect) in the northern hemisphere

27. The overall pattern of the flow around the mound of the North Pacific Ocean water centered at about 30°N (as seen from above) is (clockwise, counterclockwise). This is the North Pacific subtropical gyre.

28. **The gyre arises because winds and Earth's rotation create a _____ of water and then gravity and Earth's rotation combine to give water running downhill a twist to the _____ in the northern hemisphere.**

PART C – SOUTHERN HEMISPHERE

29. Turn your globe so the South Pole is pointing up. Hold transparency #1 with the hole at the South Pole. Be sure you can read "SH" (not "NH"). Use one finger to anchor

transparency #1 at the South Pole. Use your other hand to slide the transparency across the South Atlantic Ocean.

30. There is (a depression, mounding) of water at 30°N in the South Atlantic Ocean.

31. Now use transparency #2. Be sure you can read "SH" (not "NH"). With a marker, write "H" or "L" in the center of transparency #2.

32. Now use transparency #3. Be sure you can read "SH" (not "NH").

33. The curved arrows show the flow of surface waters. As the surface water flows "downhill", the motion of the water is deflected to the _____ by Earth's rotation (the Coriolis effect) in the southern hemisphere.

34. Draw the appropriate arrows to represent the Coriolis effect on downward moving water in the southern hemisphere.

35. The overall pattern of the flow around the mound of the North Pacific Ocean water centered at about 30°N (as seen from below) is (clockwise, counterclockwise). This is the South Atlantic subtropical gyre.

36. **The gyre arises because winds and Earth's rotation create a _____ of water and then gravity and Earth's rotation combine to give water running downhill a twist to the _____ in the southern hemisphere.**

37. While transparency #3 is still taped on the globe, turn the globe so that the North Pole is pointed up again. According to transparency #3, what direction do gyres flow in the South Atlantic Ocean?

38. Now visit the South Pacific Ocean. What direction do gyres flow in the South Pacific Ocean?

Summary of Data:

	Northern Hemisphere	**Southern Hemisphere**
Latitude of Mounding		
Deflection to the Left or Right		
Clockwise or Counterclockwise Gyre Circulation		

PART D - INTERNET RESOURCES

39. Go to http://podaac-www.jpl.nasa.gov/ost/. Click on the image to enlarge it.

40. Next we will view a map that shows sea surface height above the mean sea surface in _____.

41. What does red, orange and yellow represent on the map?

42. What is a positive sea surface height?

43. What does blue and purple represent on the map?

44. What is a negative sea surface height?

45. Approximately what is the highest sea surface height above the mean sea surface?

46. Convert the mm value to cm. _____

47. In the box below draw a line of the length in the question above.

48. Approximately what is the lowest sea surface height below the mean sea surface?

49. According to the image, sea levels are generally (high, low) in subtropical portions of the ocean basins.

50. These locations have (mounds, depressions) of water as identified earlier in this investigation. Note that factors in addition to Ekman transport affect the dynamic topography of the ocean surface. One factor is water expansion due to increased temperature as found in the western Tropical Pacific.

Conclusion: (*Answer in complete sentences*)

51. What are the differences between gyres of the northern and southern hemispheres?

52. What are the factors that lead to the movement of ocean gyres?