OCEA 112 Introduction to Oceanography Chapter 9 Homework
Due: _____ *Garrison 7th Edition*

1. A surface current is defined as one which usually involves
   a) water in the top 10 m of the ocean.
   b) water in the top 30 m of the ocean.
   c) water in the top 100 m of the ocean.
   d) water above the pycnocline.

2. The largest immediate source of energy for surface currents is
   a) the tides.
   b) heat rising from the earth's mantle.
   c) wind.
   d) Langmuir circulation.
   e) Ekman spirals.

3. A system of surface currents completing a flow circuit around the periphery of an ocean basin is called
   a) a Langmuir circulation.
   b) a gyre.
   c) a whirlpool.
   d) a tidal cycle.
   e) an Ekman spiral.

4. In the northern hemisphere the large-scale surface current patterns tend to be
   a) to the north.
   b) to the east.
   c) clockwise.
   d) counterclockwise.
   e) away from the coast.

5. In the northern hemisphere surface water driven by the wind tends to move at about 45˚ to the right of the wind direction. Water in the layer beneath the surface layer moves at an angle to the right of the surface layer. Water below that layer move yet further to the right. This situation is called
   a) a Langmuir circulation.
   b) an Ekman spiral.
   c) a gyre.
   d) a cyclone.
   e) a whirlpool.

6. Which of the following describes geostrophic gyres?
   a) They represent a balance between the Coriolis effect and the pressure gradient caused by a "hill" of water in the center of the gyre.
   b) They are often large-scale phenomena with currents following the outer edges of ocean basins.
   c) They are maintained by wind energy.
   d) All of the above.

7. The only ocean current that continues in an uninterrupted circle around the world without encountering land is the
   a) Gulf Stream.
   b) Canary Current.
   c) Kuroshio Current.
   d) Benguela Current.
   e) Antarctic Circumpolar Current (also called the West Wind Drift).

8. Western boundary currents are different from eastern boundary currents in that
   a) western boundary currents have poorly defined boundaries and move warm water towards the poles while eastern boundary currents have well defined boundaries and move cool water towards the equator.
   b) western boundary currents have well defined boundaries and move warm water towards the poles while eastern boundary currents have poorly defined boundaries and move cool water towards the equator.
   c) western boundary currents have poorly defined boundaries and move cool water towards the equator while eastern boundary currents have well defined boundaries and move warm water towards the poles.
   d) western boundary currents have well defined boundaries and move cool water towards the equator while eastern boundary currents have poorly defined boundaries and move warm water towards the poles.

9. A warm-core eddie is formed when
   a) a western boundary current like the Gulf Stream meanders and locally forms a loop which spins counterclockwise and separates from the main current.
   b) a western boundary current like the Gulf Stream meanders and locally form a loop which spins clockwise and separates from the main current.
   c) a western boundary current like the California Current meanders and locally forms a loop which spins counterclockwise and separates from the main current.
   d) An eastern boundary current like the California Current meanders and locally forms a loop which spins clockwise and separates from the main current.
   e) a Mafia hitman (often called an "Eddie" in mob parlance) feels sorry for his victims.

10. Biological productivity is ____ along the equator because of ____
   a) high … an upwelling of nutrient-rich water due to diverging surface waters.
   b) high … an upwelling of nutrient-rich water due to converging surface waters.
   c) high … a downwelling of nutrient-rich water due to diverging surface waters.
   d) low … an upwelling of nutrient-rich water due to diverging surface waters.
   e) low … a downwelling of nutrient-rich water due to converging surface waters.

11. Wind moving from north to south along the California coast causes which of the following?
   a) Upwelling of subsurface water rich in nutrients.
   b) Downwelling of surface water rich in nutrients.
   c) Upwelling of subsurface water poor in nutrients.
   d) Downwelling of surface water poor in nutrients.
   e) Warm dry summers.

12. During an El Niño event, which of the following occurs?
   a) The trade winds weaken, warm water moves west across the Pacific, and there is upwelling of water off the coast of South America.
   b) The trade winds weaken, warm water moves east across the Pacific, and there is upwelling of water off the coast of South America.
   c) The trade winds weaken, warm water moves west across the Pacific, and there is downwelling of water off the coast of South America.
   d) The trade winds weaken, warm water moves east across the Pacific, and there is downwelling of water off the coast of South America.
   e) The trade winds intensify, warm water moves east across the Pacific, and there is downwelling of water off the coast of South America.

13. Which of the following is NOT an El Niño effect?
   a) A rise in the sea level off the coasts of the Americas.
   b) An increase in ocean surface temperature in the eastern Pacific.
   c) An increase in rainfall in parts of North and South America.
   d) A dramatic decrease in Peru's fish catch.
   e) An increase in Peru's seabird population.

14. The main force driving thermohaline circulation is
    a) wind.
    b) the Coriolis effect.
    c) gravity acting on water masses of different densities.
    d) electromagnetic radiation.
    e) heating from deep in the earth's surface.

15. Two water masses A and B meet. A has a temperature of 15°C and a salinity of 34 ppt. B has a temperature of 20°C and a salinity of 37 ppt. What will happen?
    a) The two water masses will mix, forming a new water mass C which is denser than both.
    b) The two water masses will mix, forming a new water mass C which is less dense than either.
    c) The two water masses will collide, but will not mix, instead piling against each other.
    d) A will subduct under B.
    e) B will subduct under A.

16. Antarctic bottom water is formed when
    a) ice melts, releasing cold fresh water which is denser than the surrounding ocean water.
    b) ice melts, cooling surrounding ocean water and making it dense enough to sink.
    c) ice forms, releasing salt into the surrounding cold ocean water, making it dense enough to sink.
    d) water in contact with surface ice cools and sinks.

17. North Atlantic Deep Water is formed
    a) off the coast of North Carolina by the sinking of very warm but very salty water.
    b) between Greenland and Iceland by the sinking of very warm but very salty water.
    c) off the coast of North Carolina by the sinking of chilled but relatively salty water.
    d) between Greenland and Iceland by the sinking of chilled but relatively salty water.
    e) between Greenland and Iceland by the sinking of the world's coldest and saltiest water.

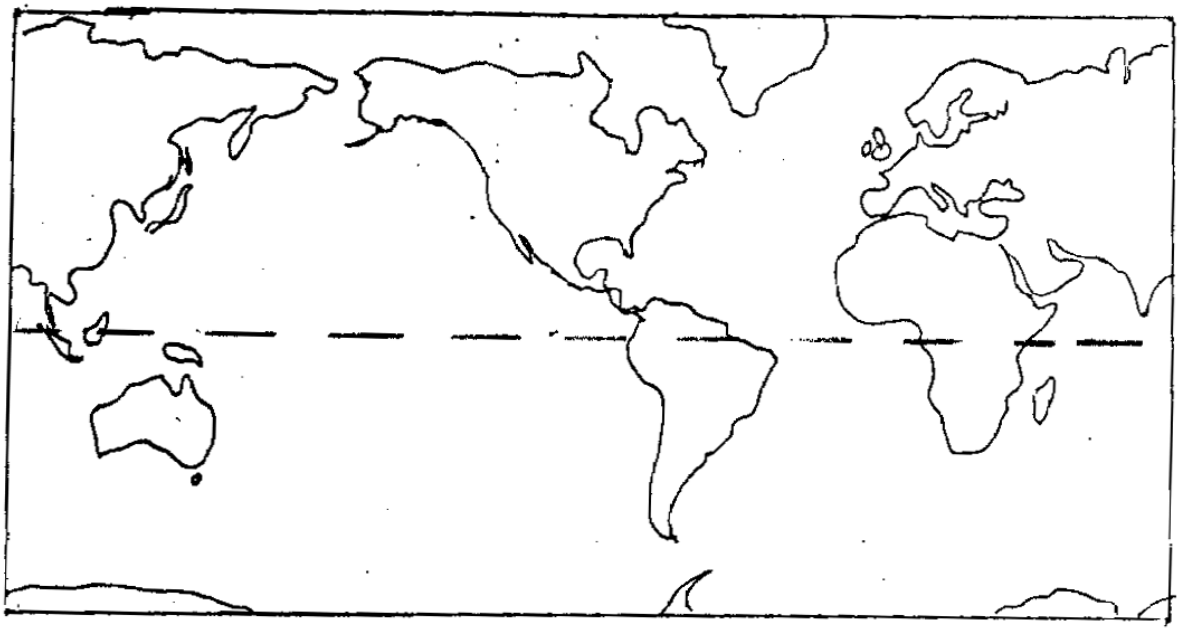
18. Mediterranean Deep Water is a relatively warm, relatively saline water mass found at a depth of about 1000 m in parts of the Atlantic Ocean. It is formed by
    a) high river input in the Mediterranean Sea to increase the salinity, followed by winter cooling.
    b) high river input in the Mediterranean Sea to increase the salinity, followed by summer heating.
    c) excess evaporation in the Mediterranean Sea to increase the salinity, followed by winter cooling.
    d) excess evaporation in the Mediterranean Sea to increase the salinity, followed by summer heating.

19. Ultimately all the deep water involved in the thermohaline circulation
    a) is subducted into the mantle.
    b) comes boiling up from bottom at certain locations, usually associated with hotspots.
    c) rises gradually to the surface over a large area in the tropical and temperate latitudes.
    d) enters continental rock through cracks, and emerges as hydrothermal vents.

20. Traditional approaches to measuring ocean currents fall into the two following broad categories:
    a) the drift method and the drag method.
    b) electrical measurements and mechanical measurements.
    c) the float method and the flow method.
    d) the surface float method and the subsurface float method.
    e) theoretical studies and float measurements.

21. Chlorofluorocarbons (CFCs), used as refrigerants from the 1930s to the 1970s until they were implicated in the destruction of the ozone layer and banned, play the following valuable role in oceanography:
    a) They dissolve in water and act as tracers of subsurface water masses that were created between the 1930s and the 1970s.
    b) Clams and oysters incorporating CFCs into their shells are much stronger than those that do not.
    c) The missing ozone layer has allowed more ultraviolet radiation to strike the earth, increasing the rate of genetic mutation in organisms, and thus speeding up evolution.
    d) Although most people are not allowed to use CFCs as refrigerants, oceanographers are allowed to, but only for refrigerating scientific samples.

22. On the figure provided below, sketch the major oceanic gyres associated with 1) the North Atlantic, 2) the South Atlantic, 3) The North Pacific, 4) The South Pacific, and 5) the Indian Ocean. Also sketch and label 1) the Antarctic Circumpolar Current, 2) Gulf Stream, 3) California Current, 4) Kuroshio Current, 5) Peru Current, 6) Brazil Curent, 7) Benguela Current, 8) North Equatorial Current, 9) South Equatorial Current, 10) Equatorial Counter-current.



23. Explain how 1) a cyclonic (counter-clockwise) gyre and 2) coastal upwelling can bring deep water to the ocean surface. Use sketches.

24. When she was a little girl, your grandmother crossed the Gulf Stream in a ship, and remembers it being swift and warm, and very distinct from the water of the central north Atlantic. Explain to your grandmother why the Gulf Stream is so swift, warm, and well-defined.

25. Your grandmother has heard a lot of talk about El Nino, and finds it rather confusing. Explain the El Nino – Southern Oscillation (ENSO) to her. Specifically, compare conditions in the Southern Equatorial Pacific during a "normal" year to those of an "El Nino" year. Also, describe some of the consequences of El Nino from Peru to California.

26. Sketch a cross-section of the Atlantic Ocean, showing the major deep water masses. Explain the origin of each deep water mass.