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**Part 1. Multiple Choice Questions. Choose the one best answer from the list, and write the correct letter legibly in the blank to the left of the question. 2 points each.**

- \_\_\_\_\_ 1. The Wedge is an example of  
A) a tidal wave.  
B) a standing wave.  
C) a gravity wave.  
D) destructive interference.  
E) an internal tide.
- \_\_\_\_\_ 2. Which statement(s) about El Niño is(are) true?  
A) It produces warm surface water along the Peru-Ecuador coast.  
B) It interrupts the southeast tradewinds and displaces the doldrums.  
C) It is associated with a displacement of the jet stream.  
D) It is also known as La Niña.  
E) a, b, and c are true.
- \_\_\_\_\_ 3. Idealized pressure belts and wind systems are significantly modified by Earth's tilted axis of rotation and:  
A) more land in the southern hemisphere  
B) differences in the latitudinal albedo  
C) Ekman transport  
D) Variations in sun spot activity  
E) the effect of Coriolis
- \_\_\_\_\_ 4. Wind-driven currents typically extend to  
A) a few centimeters depth  
B) 1000 meters  
C) the halocline  
D) the depth of the Ekman layer  
E) the bottom
- \_\_\_\_\_ 5. A geostrophic current sets up in response to  
A) density  
B) gravity  
C) temperature  
D) the tides  
E) the wind
- \_\_\_\_\_ 6. The restoring force of a fully developed wind wave is  
A) gravity.  
B) solar heat.  
C) density.  
D) surface tension.  
E) viscosity.

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- \_\_\_\_\_ 7. Tides of small amplitude occurring every two weeks with a waxing and waning moon are called \_\_\_\_\_ tides.
- A) equatorial
  - B) neap
  - C) spring
  - D) declinational
  - E) semidiurnal
- \_\_\_\_\_ 8. Water particle orbits for a shallow water wave are
- A) elliptic and flatten with decreasing depth.
  - B) elliptic and enlarge with decreasing depth.
  - C) circular and extend halfway to the seafloor.
  - D) circular at the surface and elliptical at the sea floor.
- \_\_\_\_\_ 9. A parcel of air from the South Pole moves due north along the prime meridian; its motion is independent of the Earth's rotation. Over what longitude will it be found six hours later?
- A) 90°W
  - B) 90°E
  - C) 0°
  - D) 45°E
  - E) 45°W
- \_\_\_\_\_ 10. Currents are more intense on the \_\_\_\_\_ side of the North Pacific and North Atlantic Oceans.
- A) northern
  - B) southern
  - C) eastern
  - D) western
  - E) None of the above are correct; they are not more intense on one side.
- \_\_\_\_\_ 11. A local shore wind controlled only by daily temperature variation between land and water will blow \_\_\_\_\_ during the night.
- A) 45 degrees to the right
  - B) parallel to the shore
  - C) onshore
  - D) offshore
  - E) 45 degrees to the left
- \_\_\_\_\_ 12. An estuary formed from a flooded glacial valley is called a
- A) bar-built estuary
  - B) coastal plain estuary
  - C) fjord
  - D) tectonic estuary
  - E) vertically mixed estuary

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- \_\_\_\_\_ 13. Which reservoir stores the largest amount of CO<sub>2</sub>?  
A) the atmosphere  
B) the Earth's crust  
C) the oceans  
D) the terrestrial system  
E) CO<sub>2</sub> is stored equally in these four reservoirs.
- \_\_\_\_\_ 14. The rate of coastal erosion is determined by all of the following except:  
A) degree of exposure  
B) tidal amplitude  
C) geostrophic currents  
D) geological composition  
E) coastal armoring
- \_\_\_\_\_ 15. A submergent coastline is generally associated with  
A) difficult to erode continental bedrock.  
B) trailing plate margins.  
C) falling sea level.  
D) earthquakes and volcanoes.  
E) steep, rocky beaches.
- \_\_\_\_\_ 16. All of the following are true statements about tidal waves except:  
A) they are caused by tectonic activity  
B) they are influenced by Coriolis  
C) they rotate around the ocean basins counter-clockwise  
D) they are essentially harmless away from shorelines  
E) they have wavelengths which can exceed 100 km
- \_\_\_\_\_ 17. A cotidal line is  
A) the level of no motion in a wave  
B) the point around which a tidal cell oscillates  
C) the low low tide line on shore  
D) the midway point between the two high tides in a semidiurnal tide  
E) a spatial line along which the tides are equal (same height and direction)
- \_\_\_\_\_ 18. All of the following are examples of features found along primary coasts except:  
A) coasts with extensive coral reefs  
B) drowned river valleys  
C) drowned glacial valleys  
D) subaerial deltas  
E) volcanic coasts

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**Part II. Fill in the blank/best word choice. Fill in the blank with what you think is the best answer to complete the sentence. 3 points each.**

19. In terms of temperature fluctuations, land masses are \_\_\_\_\_ stable than the oceans. In terms of salinity, coastal regions are \_\_\_\_\_ variable than the open ocean.

20. The \_\_\_\_\_ theory of tides is based on Newtonian physics, and is not as accurate as the \_\_\_\_\_ theory, which we use to produce tide tables.

21. The offset “hill” in the major basins, such as the North Atlantic, are caused by a combination of \_\_\_\_\_ force and \_\_\_\_\_.

22. The Mediterranean outflow (into the Atlantic basin) forms a layer of \_\_\_\_\_ below the surface but above the AABW.

23. Rogue waves are thought to be caused by \_\_\_\_\_.

**Part III. Short Answer. Provide the best answer to each question in a few words (not an essay), or using a diagram. 6 points each.**

24. Give an example of a major boundary current and a major wind-driven current. What (in simple terms) drives these currents? What is different about them?

25. If the Earth were exactly the same in terms of shape, tilt, continental land masses, etc. but it spun at half the velocity (so once every 48 hours), what changes would you expect in the current structure of the Pacific? Think about what would happen to Coriolis, vorticity, and the speed/strength of the gyres.

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26. In basic terms, explain why the Earth isn't ripped apart by tides when the planets align. If you were told that there is a large meteor approaching the Earth, and that it would pass between the Earth and moon, explain what you would need to know to calculate its likely effect on the oceans (you don't need to solve any equations).
27. Choose any wave type (e.g. swell, capillary, etc.) and name the type you chose. What is a typical wavelength for your wave? What is the source of energy for that wave's formation, and what is the restoring force?
28. (8 points) Draw a cross-section of the Atlantic basin from North to South pole (across the Equator), and draw/label the major water masses (there should be at least 4). Choose a location on your drawing, and draw a typical profile for temperature, salinity, and oxygen at that location, indicating on your drawing(s) which line represents each. Provide appropriate units for the axes.

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**Essay Question (20 points): Answer ONE of the questions. You will be graded on completeness, organization, and content, and your ability to synthesize the various points we have covered in class. Note: essay implies structure and complete sentences, not a list of facts.**

**Full credit will be given for an essay that attempts to integrate material from the lectures, readings, and discussions, with appropriate examples and justification. Partial credit will be given for less thorough answers. Points will be deducted for errors in content.**

- 1) Explain the general evolution of an El Nino/La Nina cycle, and compare it to the Pacific Decadal Oscillation. How are they similar, and different? Based on this discussion and your understanding of the Chavez et al. (2003) optional paper, explain how the alignment of ENSO and PDO can cause “regime shifts” in the Pacific ocean, and how that affects coastal California oceanographically and biologically.
- 2) After the tsunami event in Southeast Asia, there has been renewed interest in developing a warning system for the world’s oceans, similar to what exists in the Pacific. Based on your understanding of tsunamis and waves in general, describe how you would go about designing this warning system. As part of your answer, describe a tsunami using the terms we covered in class (so what is its approximate expected wavelength, speed, etc)? Would your warning system also predict the occurrence of rogue waves? If you wanted your system to also predict the onset of ENSO events, how would you either modify it, or use the data you are already collecting?
- 3) The Antarctic is considered to be especially important for oceanography in terms of physical, chemical, and, for global warming, biological effects. Explain why. Why isn’t the North Atlantic and North Pacific as important?