

Name (print, last name first): _____

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OCEANOGRAPHY 201

Fall, 1997

Exam #2: Section #2

Answer 1-60 on the computer-scan sheet (1 point each). Use a dark (#2) pencil only, and make marks neatly within the circles. If you change an answer, erase completely. Also, be sure your ID number is coded correctly.

PART 1: True/False (1 point each = 25 points). Mark (a) for "true" and (b) for "false".

1. Summer is hotter than winter because the Earth is closer to the sun in the summer.
2. In the Northern Hemisphere, winds and ocean currents curve in opposite directions.
3. The energy that moves wind and ocean currents comes from geothermal processes under the mid-ocean ridges.
4. The upwelling of nutrients into California waters is driven by winds and the Coriolis force.
5. T/F Conduction is the primary method of heat transport in the atmosphere.
6. The trade winds in both the southern and northern hemispheres meet at the doldrums.
7. All ocean gyres move clockwise.
8. Westward-moving currents remain more focused on the Equator than eastward-moving currents.
9. A "sea" describes an area of well-ordered waves observed far from a storm.
10. The speed of a deep-water wave depends on its height.
11. In the normal (non-El Niño) Walker Cell, air rises near South America.
12. Western boundary currents are hotter than eastern boundary currents.
13. Photosynthesis can make high-energy organic compounds, but chemosynthesis cannot.
14. At hydrothermal vents, life depends on a poisonous (to us) gas, rather than on sunlight.

15. Hydrothermal vents are found near seafloor spreading centers.
16. Sound travels farther in water than light does.
17. The major ions in seawater all have residence times that are short relative to the mixing time of the oceans.
18. The amount of water locked up in ice today is almost as large as that in the oceans.
19. River water is nearly identical to seawater in its relative proportions of dissolved ions.
20. In most parts of the oceans, nutrients are depleted in the surface waters and abundant in the deep waters.
21. Free oxygen is produced by photosynthesis and consumed by respiration and decay.
22. Most organisms get nitrogen to make protein directly from the Earth's atmosphere.
23. There is plenty to eat in the deep sea.
24. Saltier, colder water is denser than fresher, warmer water.
25. The thermohaline circulation of the oceans is responsible for a tremendous transfer of heat into the North Atlantic.

PART 2: Multiple Choice (1 point each = 35 points).

26. What direction does moving water turn in the Southern Hemisphere?
 - a) to the right
 - b) to the left
 - c) to the South
 - d) it rises
 - e) it is subducted
27. The highest and lowest tides occur:
 - a) at noon and midnight
 - b) during the first and third quarters of the moon
 - c) when Venus and Jupiter are aligned with Mars
 - d) during the full and new moons
 - e) during earthquakes

28. The wavelength of a wave
- is the crest to crest distance
 - is the trough to trough distance
 - increases as the period increases (if the speed remains the same)
 - determines how far below the surface you can feel the effects of a wave
 - all of the above
29. The polar regions radiate away more heat than they absorb from the sun.
- This is because the poles radiate away more heat than the tropics do.
 - The extra heat comes from the tropics and mid-latitudes.
 - This is why the poles keep getting colder and colder.
 - This is because ice absorbs sunlight.
 - All of the above
30. Hot air _____, while cold air _____.
- expands ... rises
 - contracts ... expands
 - expands and sinks... contracts and rises
 - expands and rises ... contracts and sinks
 - contracts and rises ... expands and sinks
31. When water vapor condenses to liquid water in the atmosphere:
- latent heat is released to the surrounding air.
 - latent heat is absorbed from the surrounding air.
 - the air descends.
 - it causes the Coriolis effect.
 - it forms a Walker cell
32. Between 30 and 60 degrees latitude
- there is a Hadley cell.
 - prevailing winds blow from the southwest
 - currents move towards western ocean boundaries
 - the Coriolis force deflects winds to the left
 - all of the above
33. Which of the following occurs in the Eastern Pacific during an El Niño event:
- Surface waters are warmer than usual.
 - Fisheries off the coast of South America decline.
 - The thermocline is elevated.
 - Sea level is higher than usual in the Eastern Pacific.
 - All of the above.

34. When waves bend around an island, that is

- a) reflection
- b) refraction
- c) scattering
- d) absorption
- e) convection

35. When hydrothermal fluid reenters the ocean:

- a) it heats up to 380 degrees C.
- b) photosynthesis occurs.
- c) insoluble sulfide salts precipitate out
- d) tube worms feed directly on the hydrogen sulfide
- e) all of the above

36. The pycnocline refers to the depth in the ocean where

- a) the temperature changes rapidly
- b) the salinity changes rapidly
- c) the density changes rapidly
- d) the pressure changes rapidly
- e) sharks hang out and wait for surfers

37. As a polar solvent, water has special physical properties, including

- a) high surface tension
- b) capillary action
- c) high adhesion, causing wetting of surfaces
- d) high heat capacity and latent heat
- e) all of the above

38. Without salts in seawater

- a) There would be no life in the oceans.
- b) Its physical properties would be different.
- c) It would freeze at a higher temperature.
- d) It would not circulate in the same manner that it does now,
- e) all of the above.

39. The seas are salty because

- a) Water is a powerful solvent, which effectively dissolves many compounds as salts.
- b) Rivers carry salts to the sea, and these are left behind in solution when the water evaporates or freezes
- c) Removal processes are highly efficient for some ions and inefficient for others; the composition of seawater is thus determined mainly by the output **rather than the input** processes.
- d) Both water and chlorine were outgassed in large quantities from the solid Earth early in its history; their ratio largely determines the salinity of seawater.

e) all of the above.

40. The concept of steady state

- a) is not important in chemical oceanography.
- b) in a system, applies to a dynamic feature that is apparently unchanging, because inputs are equal to outputs.
- c) happens when a given chemical species simply accumulates in a dynamically changing reservoir.
- d) applies in nearly every dynamic system in nature, regardless of the time scale.
- e) none of the above

41. Conservative elements are those which

- a) are used by living organisms to build their soft tissues.
- b) have residence times that are long relative to the stirring time of the oceans.
- c) do not vary from place to place in the oceans, except as salinity varies.
- d) have close ties to the Republican Party.
- e) both b) and c)

42. In the oceans, a limiting nutrient is

- a) an essential nutrient that, if missing, limits growth in a given **water mass**.
- b) usually either nitrate or phosphate.
- c) one which limits the penetration of light in the surface waters.
- d) both a) and b)
- e) all of the above

43. Organisms can remove nutrients almost completely from surface waters of the ocean, yet life there goes on because

- a) not all nutrients are necessary to sustain life.
- b) most of the nutrients are recycled rapidly in the surface waters, before they can sink out of the photic zone.
- c) nutrient-rich deep waters upwell in some locations, restoring nutrients to the surface waters.
- d) both b) and c)
- e) all of the above

44. Residence time is

- a) a useless and outdated concept in oceanography.
- b) the mean length of time that a given chemical species resides in a given reservoir, relative to some input or output process.
- c) calculated by dividing the amount of a given chemical species in a reservoir by the rate of input or output of that species to or from the reservoir.
- d) both b) and c)
- e) none of the above

45. The thermohaline circulation of the oceans refers to
- the tendency for all ocean water to sink beneath the thermocline and halocline.
 - the circulation of the deep ocean that is driven by differences in density among different water masses, which in turn are caused by differences in temperature and salinity.
 - the circulation of surface water that is driven mainly by the winds.
 - the circulation of surface water around the continent of Antarctica that is driven by freezing of seawater and production of dense, extremely salty water.
 - none of the above.
46. Density differences in seawater are produced
- only in deep waters, by freezing of ice along the bottom.
 - only in deep waters, by changes in temperature and salinity, by the processes of heating and cooling and evaporation and freezing.
 - only in surface waters, by changes in temperature and salinity, by the processes of heating and cooling and evaporation and freezing.
 - only in surface waters, and only by phase changes such as formation of ice.
 - none of the above.
47. The salinity of surface waters in the oceans
- varies mainly in response to the difference between evaporation and precipitation at a given locality,
 - varies mainly in response to the density of seawater at a given locality.
 - varies mainly in response to variations in the depth of the thermocline.
 - is constant.
 - none of the above,
48. The mixing time of the ocean is about
- 1 month
 - 10 years
 - 200 years
 - 1000 years
 - 10,000 years
49. Salinity in the ocean around Hawaii is high because
- There is a lot of salt in tropical rainfall
 - Density causes salinity to increase
 - Volcanoes produce salt
 - Condensation produces cloud droplets
 - Evaporation exceeds precipitation

50. About 50% of light is absorbed by the time the light has passed through how much water?

- a) 0.1 meter
- b) 1 meter
- c) 10 meters
- d) 100 meters
- e) 1000 meters

51. In the daytime, when the air pressure over the land is higher than over the ocean, what may result?

- a) offshore breezes
- b) onshore breezes
- c) Trade Winds
- d) Longshore drift
- e) Tropical cyclones

52. North Atlantic Deep Water forms because:

- a) the Gulf Stream has lost heat to the atmosphere
- b) rivers add fresh water to the North Atlantic
- c) nitrate is a limiting nutrient
- d) winds cause surface currents
- e) all of the above

53. The average salinity of seawater is 35 grams of salt in every

- a) cubic centimeter of water
- b) cubic meter of water
- c) gallon of water
- d) 1000 grams of water
- e) 1000 kilograms of water

54. The longest period waves are:

- a) tsunamis
- b) wind-generated deep-water waves
- c) seiches
- d) capillary waves
- e) tides

55. The ocean current that carries heat into the North Atlantic is:

- a) the Kuroshio current
- b) the Gulf Stream
- c) an eastern boundary current
- d) the West Wind Drift
- e) the Equatorial Undercurrent

56. Hydrothermal fluids do not boil at 380 T at the bottom of the ocean because:

- a) pressure raises the boiling point
- b) sea water does not boil
- c) there are too many chemicals dissolved in seawater
- d) bacteria grow in the hot water
- e) the particles in the water prevent it from boiling

57. Tsunamis have wavelengths that are approximately:

- a) 20 cm
- b) 20 m
- c) 2 km
- d) 200 km
- e) 2000 km

58. The energy in hurricanes comes from

- a) subsidence in the Walker cell
- b) infrared heating of clouds
- c) rotating currents in the gyres
- d) Trade Winds
- e) the condensation of water vapor

59. Tsunamis are:

- a) waves with periods less than one minute
- b) caused by the interaction of tidal forces and winds
- c) shallow-water waves
- d) waves with periods of approximately 12 hours
- e) none of the above

60. Upwelling water is usually

- a) full of nutrients
- b) depleted of nutrients
- c) found in the North Atlantic
- d) no different than any other seawater
- e) warmer than surface water

PART 3: Short Essay (15 points). Answer the following three questions entirely within the space provided. Think your answer through before starting to write. Write legibly--print if your handwriting is poor, because if the grader can't read it, it will be marked wrong.

1. State the Principle of Constant Proportions. To what group of ions does it mainly apply? (5 points)

2. (5 points - Show your working!) A wind-generated wave is travelling **in deep water** with a period of 10 seconds. What is its wavelength in meters?

This wave approaches a coast where the water is 1 meter deep. What is its speed now?

If its period has not changed, what is its wavelength now?

3. Draw a picture of the Earth showing the main wind circulation (give their names!) cells and the directions of the prevailing winds. (5 points)