

Welcome to 2020 Camas Invitational!

You are about to embark on a **Dynamic Planet adventure.**

You have 50 minutes from the time you start to submit your completed test. If you have not submitted your responses at the end of that time, your responses will be submitted automatically.

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**1. (1.00 pts)** The deepest trench we know of is the Mariana Trench.

☐ True ☐ False

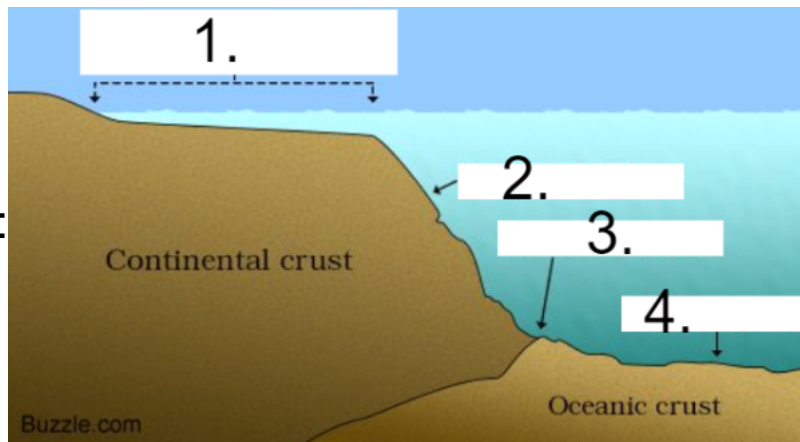
**2. (3.00 pts)** Name the three features of the continental margin.

**3. (5.00 pts)** Describe what a mid-ocean ridge is and how it forms.

**4. (2.00 pts)** What evidence convinced scientists that ocean plates diverge at midocean ridges?

**5. (4.00 pts)** Label 1-4 on Image B.

Image B:



6. (9.00 pts) Name each stage of the Wilson Cycle in order and briefly describe what happens at each one.

7. (2.00 pts) Rank the following categories of water by increasing salinity

- ☐ A) Brine, brackish, saline, seawater
- ☐ B) Brackish, brine, saline, seawater
- ☐ C) Brackish, saline, brine, seawater
- ☐ D) Brine, brackish, seawater, saline
- ☐ E) Brackish, seawater, brine, saline

8. (2.00 pts) What is the average salinity of seawater?

- ☐ A) 1%
- ☐ B) 3.5%
- ☐ C) 5%
- ☐ D) 6.8%
- ☐ E) 8.9%

9. (2.00 pts) The current standard for ocean water salinity is:

- ☐ A) Practical Salinity Scale
- ☐ B) Reference Salinity Scale

- ☐ C) Revised Salinity Scale
- ☐ D) Standard Salinity Scale
- ☐ E) Normal Salinity Scale

**10. (1.00 pts)** Seawater density increases as you go deeper in the ocean.

- ☐ True ☐ False

**11. (6.00 pts)** Identify the six main salts found in sea water in order from highest to lowest composition by mass.

**12. (2.00 pts)** What is the typical range of density for seawater?

- ☐ A) 995-1010 kg/m<sup>3</sup>
- ☐ B) 1010-1018 kg/m<sup>3</sup>
- ☐ C) 1020-1027 kg/m<sup>3</sup>
- ☐ D) 1035-1044 kg/m<sup>3</sup>
- ☐ E) 1045-1051 kg/m<sup>3</sup>

**13. (3.00 pts)** Give a thorough explanation of how precipitation causes the salinity of the ocean to increase.

**14. (1.00 pts)** The primary input to the oceanic heat budget is geothermal heat.

- ☐ True ☐ False

**15. (2.00 pts)** To what depth does shortwave radiation penetrate ?

- ☐ A) 100-1000m
- ☐ B) 0.1-1m
- ☐ C) 0.01-0.1m
- ☐ D) 1-100m
- ☐ E) 1000-10000m

**16. (2.00 pts)** Water is almost \_\_\_\_\_ to longwave radiation.

- ☐ A) Translucent

- ☐ B) Opaque
- ☐ C) Hazy
- ☐ D) Transparent
- ☐ E) Colorless

**17. (2.00 pts)** What is the average temperature of ocean surface waters?

- ☐ A) 16°C (60.8°F)
- ☐ B) 17°C (62.6°F)
- ☐ C) 18°C (64.4°F)
- ☐ D) 19°C (66.2°F)
- ☐ E) 20°C (68.0°F)

**18. (2.00 pts)** What is the definition of advection?

- ☐ A) The bulk transport of heat, mass, or some of a substance.
- ☐ B) Heat transfer in a gas or liquid by the circulation of currents from one region to another.
- ☐ C) An introduction of something from an outside source.
- ☐ D) A physical movement of water; if in the ocean, called an ocean current, which can be further subdivided into surface currents and deep currents.
- ☐ E)

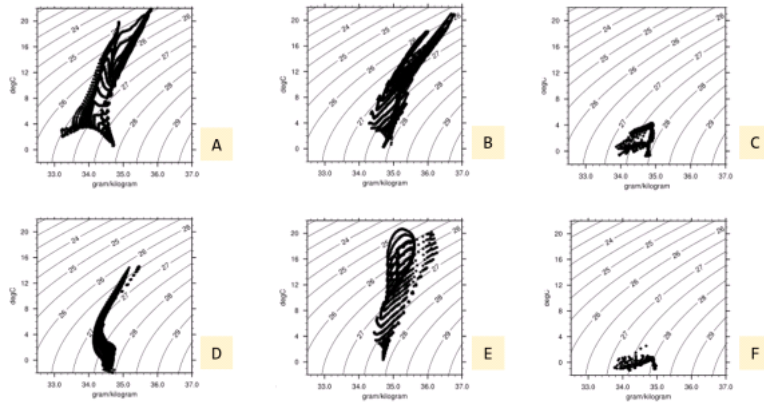
A process by which materials move through fluids by random molecular movement from areas of high concentration to areas in which they are in lower concentrations, thus becoming evenly distributed.

**19. (2.00 pts)** Order the three main layers of the ocean from top to bottom:

- ☐ A) Deep, Mixed, Pycnocline
- ☐ B) Mixed, Deep, Pycnocline
- ☐ C) Pycnocline, Mixed, Deep
- ☐ D) Pycnocline, Deep, Mixed
- ☐ E) Mixed, Pycnocline, Deep

**20. (3.00 pts)** Differentiate between pycnocline, halocline, and thermocline.

**21. (3.00 pts)** Identify the letter for these three oceans, in order: Pacific, Atlantic, Indian.



**22. (3.00 pts)** Identify the following three oceans by letters in the image of the previous question: Southern Ocean, Arctic Ocean, Labrador Sea.

**23. (2.00 pts)** These are all aspects of upwelling **EXCEPT**:

- ☐ A) It is wind-driven.
- ☐ B) It consists of the motion of cool nutrient-rich water towards the surface.
- ☐ C) Cool water at the surface is displaced by water coming up towards the surface.
- ☐ D) Nutrientless water at the surface is displaced by water coming towards the surface.
- ☐ E) It is the opposite of downwelling.

**24. (1.00 pts)** Are you more likely to see downwelling occur at colder waters or warmer waters?

**25. (2.00 pts)** State which way gyres travel in the Northern and Southern Hemispheres.

**26. (2.00 pts)** The motion of individual water molecules in a wave is

- ☐ A) Straight Forward
- ☐ B) Random
- ☐ C) Up and Down

- ☐ D) Side to Side
- ☐ E) Circular

**27. (2.00 pts)** Waves on the surface of the ocean are considered \_\_\_\_\_ waves.

- ☐ A) Transverse
- ☐ B) Rotational
- ☐ C) Longitudinal
- ☐ D) Medial
- ☐ E) Orbital

**28. (2.00 pts)** Which is true of a wave as it approaches the shore?

- ☐ A) Its frequency stays constant
- ☐ B) Its wavelength stays constant
- ☐ C) Its amplitude stays constant
- ☐ D) Its velocity stays constant
- ☐ E) All 4 of these quantities stay constant
- ☐ F) None of these quantities stays constant

**29. (2.00 pts)** Give a thorough explanation of longshore currents.

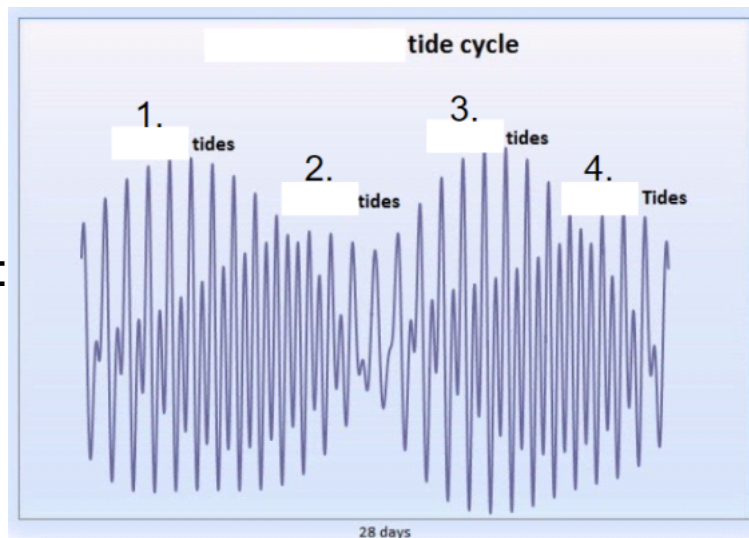
**30. (1.00 pts)** Wave refraction is when waves in shallow water become bent and begin to run perpendicular to the shoreline.

- ☐ True
- ☐ False

**31. (4.00 pts)**

Label 1-4 on Image A.

Image A:



32. (1.00 pts) The critical ratio of wave height to wavelength is 1:7.

☐ True ☐ False

33. (2.00 pts) A wave has a speed of 9.8 m/s and a period of 20 seconds. What is its wavelength?

34. (2.00 pts) A certain wave has a wavenumber,  $k$ , of 0.628 feet and amplitude 0.625 feet. Can this wave exist?

35. (4.00 pts)

Tsunami André, formed by an earthquake off the coast of Candyland, hits Waffleland after 7.8 hours. Candyland and Waffleland are 4200 km away from each other. Assuming the average wavelength of a tsunami is 200 km, what is the wave period of this tsunami **in minutes**? Round to 2 significant figures.

**36. (2.00 pts)** Where are the rates of sediment accumulation highest?

- ☐ A) Beneath the equator
- ☐ B) Near the mouths of large rivers
- ☐ C) Along the mid-ocean ridge
- ☐ D) In the deep sea, far from land
- ☐ E) Near the edge of glaciers

**37. (2.00 pts)** Turbidity currents produce all of the follow **EXCEPT**:

- ☐ A) Underwater seamounts
- ☐ B) Fans
- ☐ C) Graded Deposits
- ☐ D) Submarine Canyons
- ☐ E) None of the above

**38. (2.00 pts)** What is isostasy?

- ☐ A) The process in which waves grow larger as the sun sets.
- ☐ B) A condition of equilibrium in which Earth's crust floats on the mantle.
- ☐ C) An effect that occurs as surface current flows past an island and causes surface water to be carried away from the island on the downcurrent side.
- ☐ D) The period of time associated with the peak of low tide when there is no visible flow of water into or out of bays and rivers.
- ☐ E) Long journeys undertaken by many marine species for the purpose of successful feeding and reproduction.

**39. (1.00 pts)** What does SONAR stand for?

**40. (8.00 pts)** Give one sentence describing the following Oceanic Tools:

- a. Bailer-
- b. Dipper-
- c. Level Loggers-
- d. Pressure Loggers-
- e. Dredges-
- f. Acoustic Doppler Current Profiler (ADCP)-
- g. BIOMAPER-
- h. Gravity Corer-

**41. (2.00 pts)** What does the Alvin do?



42. (4.00 pts) What is the EM 300 system, what does it do, and how does it work?

43. (1.00 pts) What does ENSO stand for?

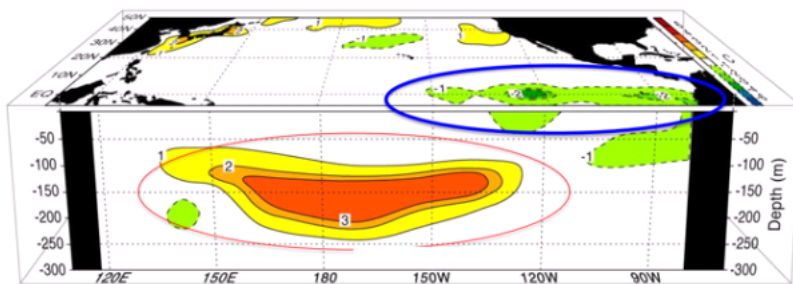
44. (2.00 pts) Differentiate between El Niño and La Niña.

45. (3.00 pts) What is the Pacific Decadal Oscillation and where is it located?

46. (2.00 pts)

Picture below shows the three-dimension temperature anomaly in Pacific Ocean, with red circle representing positive temperature change vs. average, and blue circle representing negative temperature change vs. average.

- 1) What is the impact of such anomaly to thermocline?
- 2) Such anomaly can be a precursor for \_\_\_\_\_ event in about one year.

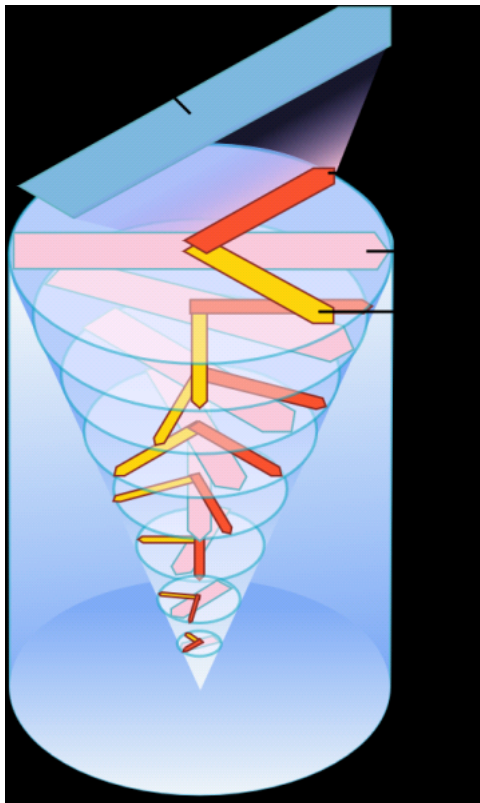


47. (4.00 pts) Describe the 4 types of reefs.

48. (2.00 pts) In the Northern Hemisphere, the Coriolis Effect deflects moving objects

- ☐ A) To the Left
- ☐ B) To the Right
- ☐ C) Up
- ☐ D) Down
- ☐ E) It has no effect

49. (2.00 pts) Consider this image of an Ekman spiral.



What does the the blue arrow represent?

What does the yellow arrow represent?

What does the pink arrow represent?

**50. (3.00 pts)** For a parcel of water at an latitude of  $30^\circ$  with a northward velocity of 2 m/s, what is the acceleration due to Coriolis effect, in  $m/s^2$ ?

Describe the solution step to get full points.

**51. (5.00 pts)**

Assume we have a rapid flow in a channel of 4 km width on the north America continent with a poleward velocity of 2 m/s. If we ignore the effect of density stratification, turbulence, wind, just consider the geostrophic balance, what is the difference in height on the two side of the bank, in meters? Which side will be taller, east or west?

Describe your solution steps and rationale to get full points.

**52. (8.00 pts)**

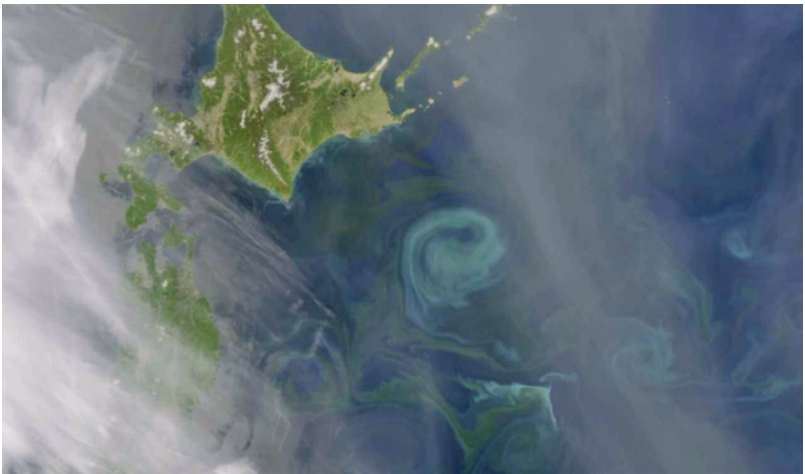
Now a more difficult question - In reality, density of the water is not uniform across the depth. Assume we can treat the water parcel as a top layer of density  $\rho_1$  above another layer of density  $\rho_2$ , there is a sharp interface at a center depth of density discontinuity. Let's reconsider the same scenario described in the previous question except now that flow is only happening in the top layer with density  $\rho_1$ . We can further assume  $\rho_1 = 0.99\rho_2$ , i.e. with low density water above .

- 1) Under geostrophic balance, would low density top water shift to the east bank or west bank? [1 pt]
- 2) Calculate the tilting angle of this density interface under such idealistic flow condition (top layer = 2m/s, bottom layer = 0m/s), Express your answer in degrees [5 pts]
- 3) In Oceanography, we can detect the direction of geostrophic flow based on iso-thermal depth profile, or shifts in pycnocline. Why is that? [2 pts]

**53. (9.00 pts)**

Kuroshio, also known as the Black or Japan Current (黒潮), is a north-flowing, warm ocean current on the west side of the North Pacific Ocean.

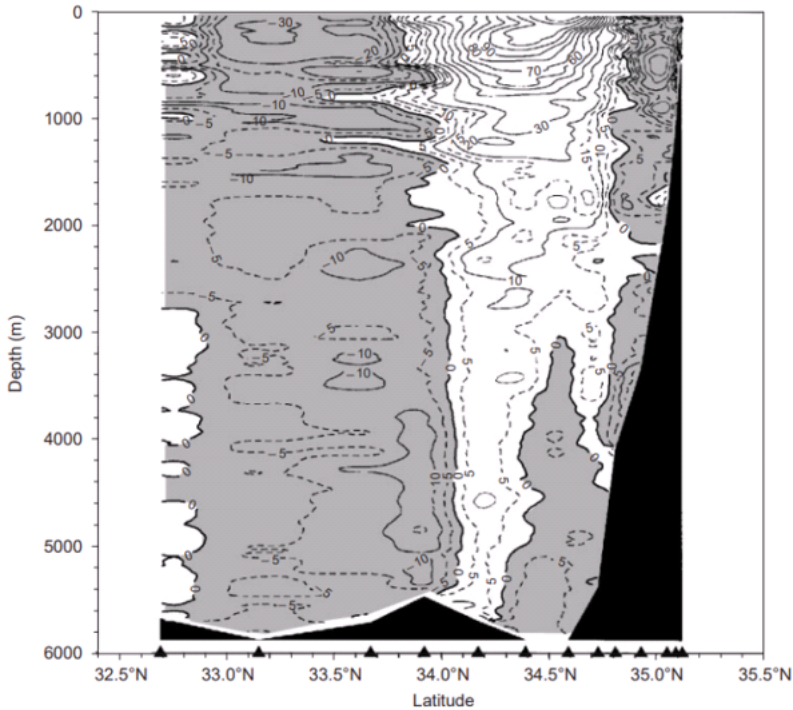
- (1) What is the main driving force for Kuroshio current [1 pt]
- (2) This current spins off strong eddy as shown in the picture below. How does such eddy contribute to global warming? [2 pts]



(3) A cross section of the strong eddy at the main branch of Kuroshio current is show below with velocity contours marked in unit of cm/s. Here the shaded area indicate weaker south-west flow.

Estimate the flow rate of the stronger north-eastward flow (unshaded area), express your answer in Sverdrup. [5 pts]

(4) This is data collected in 1993. what is the likely technique used to get such velocity profile? [1 pt]



Great job! You did it!