

# 2016 Science Olympiad CPCC Invitational Dynamic Planet (Oceanography)

School Name: \_\_\_\_\_

Student Names: \_\_\_\_\_

## Instructions

1. Do NOT open the test until told to!
2. Cell phones should be turned off.
3. Make sure to read the questions carefully. Write your team number on EVERY page.
4. You may take apart the test. However, the test MUST be placed back in the correct order BEFORE time is called!
4. Good Luck. This test is long.

**ANSWER KEY**

1. Which of the following is **NOT** a strong factor on why shoreline features vary from place to place around the Earth?
  - a. Coast is sinking, stable, or rising
  - b. Intensity of wave activity
  - c. Type of rocks at the shoreline
  - d. Nature of coastal currents
  - e. **Type of sediment at the shore**
  
2. What result does the Coriolis Effect have on masses of air or water that are changing latitude?
  - a. The results are unpredictable; currents can veer right or left in either hemisphere.
  - b. They veer to the left in the Northern Hemisphere and the right in the Southern Hemisphere.
  - c. **They veer to the right in the Northern Hemisphere and the left in the Southern Hemisphere.**
  - d. They veer to the left in both hemispheres.
  
3. How are wave-cut cliffs and wave-cut platforms related?
  - a. Cliffs are left in the place of platforms as the platforms move landward by wave undercutting.
  - b. Cliffs are cut horizontally, making horizontal tables of rock; vertical platforms are left in their place at sea level.
  - c. **Cliffs are cut landward by wave action at the shoreline; horizontal platforms are left in their place at sea level.**
  - d. Cliffs are left as arches and sea stacks as they are cut landward; horizontal platforms are eroded remnants of marine terraces offshore of these.
  
4. Which of the following features is not associated with subduction?
  - a. **Basaltic volcanism and rifting**
  - b. Andesitic volcanism
  - c. Crumpled and fractured continental rocks
  - d. Volcanic island arc chains
  
5. Select the ion which is not a major constituent of seawater.
  - a. Sodium
  - b. Chloride
  - c. **Iodine**
  - d. Calcium
  
6. What is the difference between an ebb current and a flood current? Mention where the current is moving towards and when during the tidal cycle the current happens.

**Ebb current = current is seaward moving (1 point) as tide falls (1 point)**

**Flood current = current advances into coastal zone (1 point) as tide rises (1 point)**
  
7. Which of the following is **NOT** one of those theories that explain how a barrier island forms?
  - a. Was a former sand-dune ridge that originated along the shore during the last glacial period.
  - b. **Originated as a wave-cut platform that was uplifted as a marine terrace, now covered with sand.**
  - c. When turbulent waters in the line of breakers heap up sand scoured from the bottom.
  - d. Originated first as spits that were subsequently severed from the mainland by wave erosion or a rise in sea level.

8. Which of the following best describe how tides form by the influence of the Moon? Choose **ALL** that apply.
- The ocean water is pulled toward the Moon on the side of the Earth facing the Moon.
  - The ocean water is pulled away from the Moon on the side opposite the side of the Earth that faces the Moon.
  - The ocean water on the sides perpendicular to the Moon is stretched toward the Moon-facing side of the Earth.
  - The ocean water on the sides perpendicular to the Moon is squeezed toward the side of the Earth opposite of the Moon.
9. The depth of the mixed layer in a thermocline is greatest during the:
- Summer
  - Fall
  - Winter
  - Spring

10. Identify the device shown to the right. What does the device sample or measure?

Ekman grab (1 point); sediment samples from the ocean bed (1 point)

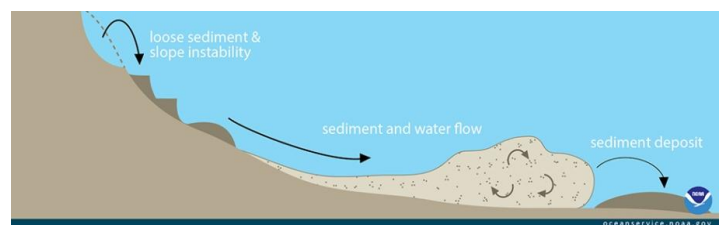


11. Which of the following is the difference between passive and active continental margins? Choose **ALL** that apply.
- Passive margins are not situated along active plate boundaries, whereas active margins are.
  - Passive margins are found along the western coasts of most of the Americas, whereas active margins are found along most of the Atlantic coasts.
  - Passive margins are found along most of the Atlantic Ocean coasts, whereas active margins are found along the western coasts of most of the Americas.
  - Passive margins are situated along active plate boundaries, whereas active margins are not.

12. Identify the current pictured. Explain how it is triggered.

Turbidity current (1 point)

Seismic activity (earthquakes); collapsing slopes (1 point)



13. Which of the following has been discovered about the ocean floor located next to, and parallel to, oceanic volcano chains?
- Abyssal plains
  - Mermaids exist
  - Ocean ridges
  - Linear trenches

14. Which of the following is NOT true about water?

- a. It is the only substance to occur naturally as a solid, liquid, and gas on Earth.
- b. It dissolves more substances than any other solvent.
- c. It has the highest specific heat of all substances.
- d. It is very compressible.

15. What is the difference between summertime and wintertime beaches? Make sure to mention the differences in wave activity, type of berm, and type of beach face.

Summertime = light wave activity (1 point), wide/sandy berm (1 point), steep beach face (1 point)

Wintertime = heavy wave activity (1 point), narrow rocky berm (1 point), flattened beach face (1 point)

16. Which of the following best explains the presence of thousands of feet of coral limestone beneath *atolls* (like the ones in the Pacific Ocean)?

- a. Sea level has fallen thousands of feet since the reef began to grow.
- b. An eroded volcanic seamount rose thousands of feet after the limestone formed.
- c. The eroded volcano slowly sank as sea level remained steady or rose gradually.
- d. The volcano never reached the surface, allowing a very thick cap of coral limestone to accumulate.

17. What is the average salinity of the ocean? Give your answer in the most commonly used unit of salinity. At what latitudes does ocean salinity tend to be the highest? Why?

35 ppt (1 point); 30 N/S or Desert Latitudes (1 point); Evaporation exceeds precipitation, which increases salinity (1 point)

18. Under what conditions does coastal upwelling commonly occur? Choose **ALL** that apply.

- a. Where biotic productivity is high enough to sustain it
- b. Only on the western coasts of continents
- c. Only on the eastern coasts of continents
- d. Where winds blow toward shore
- e. Where winds blow away from shore

19. Explain how atolls form. Mention the stages that occur before an atoll and the person who presented the theory.

A volcanic island starts to subside and a fringing reef forms (1 point). Subsidence continues and the fringing becomes a barrier reef (1 point). The island sinks under the sea and the barrier reef becomes an atoll surrounding an open lagoon, often circular in shape (1 point). Charles Darwin created this theory (1 point).

20. As waves move along the surface of the water, what do water particles do?

- a. They move back and forth in a direction parallel to wave motion
- b. They move back and forth in a direction perpendicular to wave motion
- c. They move along the crests of waves and can travel thousands of miles
- d. They oscillate in circles whose diameters decrease with depth
- e. They oscillate in circles whose diameters increase with depth

21. High evaporation rates and relatively low fresh water inflow may result in which type of estuary?

- a. Inverse
- b. Partially Mixed
- c. Salt Wedge
- d. Well Mixed

22. What is the difference between surf and swell? Make sure to mention what is happening to each wave and where in the ocean it occurs.

Surf = waves are slowing down/breaking (1 point); occurs at coast or in shallow water (1 point)

Swell = waves are travelling (not being generated or dissipated) (1 point); occurs in open water (1 point)

23. Select the following relationship of water properties that is not correct.

- a. Increased salinity: increased density
- b. Increased temperature: decreased density
- c. Increased temperature: increased salinity
- d. Increased evaporation: increased salinity

24. Using data from the table shown at the right, what % of the chemical elements found in seawater is salt?

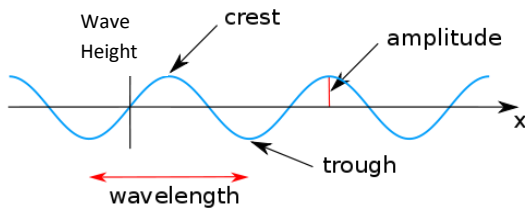
- a. 99%
- b. 87%
- c. 90%
- d. 92%

	Seawater	Freshwater
Sodium	450	0.3-5
Calcium	10	0.07-2
Magnesium	50	0.04-3
Chloride	513	0.23-10
Sulfate	26	0.05
Osmolality	1050	1-20

25. Why is the continental shelf so much narrower at active continental margins?

- a. Continental land masses do not supply much sediment to the oceans, so the shelf does not build outward very far.
- b. The presence of the deep-sea trench effectively eliminates the continental shelf.
- c. The presence of a mountain at the edge of the continent prevents the finer sediment from building the margin.
- d. Active subduction causes the sediment to build up, and though narrow, the shelf is very thick and rocky.

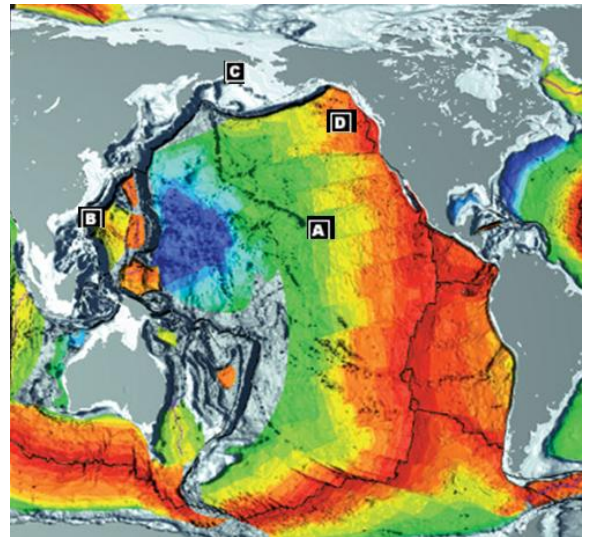
26. Draw a diagram of an ocean wave. Label the crest, amplitude, height, trough, and wavelength.



1 point for each (6 in total)

27. Use the diagram to fill in the blanks for questions 27a-27c with the correct letter (A – D). Each question may have multiple answers.

- a. oceanic divergence \_\_B\_\_
- b. extensive volcanic hotspot \_\_D & A (2 points)\_\_
- c. ocean-continental convergence \_\_C\_\_



28. What are tides of large amplitude that occur every two weeks called?

- a. Diurnal Tides
- b. Equatorial Tides
- c. Neap Tides
- d. Semidiurnal Tides
- e. Spring Tides

29. Where are the greatest tidal ranges on earth found?

Bay of Fundy

30. The layer of Earth that is rigid, mobile, and includes the continents is called the

- a. Asthenosphere
- b. Mesosphere
- c. Lithosphere
- d. Mantle

31. Name the three types of breaking waves. Mention the shape of the wave and ocean slope associated with each type.

Spilling breakers = ocean floor has a gradual/gentle slope; relatively gentle wave (3 points)

Plunging breakers = ocean floor has a moderate slope; surfer waves (crests form open curl) (3 points)

Surging breakers = ocean floor has an extremely steep slope; long and low waves (“bulge” up near the shoreline) (3 points)

32. As a result of seafloor spreading:

- a. New ocean crust is generated at ridges to accommodate the spreading plates.
- b. Continents attached to the plates on each side of the ridge slowly move apart.
- c. The age of ocean crust increases with increasing distance away from the ridge.
- d. A record of paleomagnetic reversals is recorded in rocks that formed at the ridge.
- e. All of the above.

33. What is the difference between a guyot and a seamount?

A seamount is an underwater mountain of volcanic origin (1 point); guyot is a flattopped seamount (1 point)

34. When waves reach an irregular coastline, how is their energy distributed?

- a. It is equally distributed between bays and headlands
- b. It is focused on bays and cuts them deeper
- c. It is focused on headlands and erodes them back
- d. It is deflected back to sea

35. If you observe a semidiurnal high tide at 3:00 PM, the next high tide will occur at about what time the next day?

- a. 2:50 P.M.
- b. 2:25 A.M.
- c. 1:10 P.M.
- d. 3:25 A.M.

36. Why is the ocean salty? Make sure to include sources of salt.

Carbonic acid dissolves minerals and forms ions/ ions from rock get to the ocean through rivers (1 point)

Sources =

37. Which of the following statements on ocean salinity is not correct?

- a. Average salinity is 35 percent.
- b. There is an average of 35g of dissolved salt in every kg of seawater.
- c. Salinity of ocean surface water is associated with latitude.
- d. Salinities will be lower in areas of high precipitation.

38. Wind driven open-ocean surface currents:

- a. Move at the same speed as the wind.
- b. Speed up when moving through narrow gaps.
- c. Slow down when moving through narrow gaps.
- d. Transport small amounts of water when compared to rivers.

39. What is hypoxia? What are the causes and effects of hypoxia? Where has hypoxia occurred in the US?

Hypoxia is low/depleted oxygen in a body of water (DO concentration ppm < 2-3ppm) (1 point)

Causes: Temperature = as temp increases, water loses ability to hold dissolved oxygen and DO goes down; Salinity = inverse relationship between salinity and DO (increase in salinity leads to decrease in DO), could also create another layer with denser water (happens in estuaries); Nutrient Pollution/Fertilizer = algae grows, decomposes, depletes DO (2 points)

Effects: Less DO leads to a "dead zone"; marine life dies or leaves area (2 points)

Ex. Gulf of Mexico, Coast of Oregon/Washington, Great Lakes (1 point)

40. If you were to collect samples at the following locations along the sea floor of the North Atlantic Ocean, which sample of rock would be the oldest?
- Along the spreading ridge
  - Where the spreading ridge comes ashore in Iceland
  - Just east of the spreading ridge
  - Just west of the spreading ridge
  - Just off the coast of North America
41. Which of the following does not correctly describe global ocean circulation?
- North Atlantic Deep Water mixes with and is cooled by Antarctic Bottom Water.
  - Deep water from the Atlantic supplies upwellings in the Indian and Pacific Oceans.
  - Cold water formed in the North Pacific comprises the largest source of deep water.
  - Surface flow from the Pacific and Indian oceans replaces deep water formed in the North Atlantic.
42. If the high tide of a diurnal tide occurs at 10:00 AM on one day, when will the next high tide occur?
- 10:25 P.M. the same day
  - 10:50 A.M. the next day
  - 10:00 A.M. the next day
  - 10:00 P.M. the same day
  - 10:25 A.M. the next day
43. What is the difference between continental and oceanic crust? Make sure to mention differences in density, age, thickness, and rock type. (4 points)

Continental = less dense, older, thicker, granite

Oceanic = more dense, younger, thinner, basalt

44. Identify the device shown to the right. What does the device sample or measure?

Secchi disk (1 point); turbidity (1 point)



45. Which of the following is **NOT** a mechanism for regulating the ocean's salt balance?
- River discharge
  - Sea spray
  - Hydrothermal vent activity
  - All of the above are mechanisms
46. The principle explaining the variable buoyancy of crustal material is
- eustasy
  - tomography



- c. topography
- d. isostasy

47. Which of the following objects has the greatest tide generating force on Earth?

- a. Moon
- b. Sun
- c. Venus
- d. Jupiter

48. Which type of crust will subduct most rapidly?

- a. Old continental crust
- b. Young continental crust
- c. Old oceanic crust
- d. Young oceanic crust

49. Select the statement that does not correctly describe submarine canyons.

- a. They are steep sided valleys with V-shaped profiles.
- b. They are eroded back into the continental shelf.
- c. They extend across the abyssal plains.
- d. All of the above are correct.

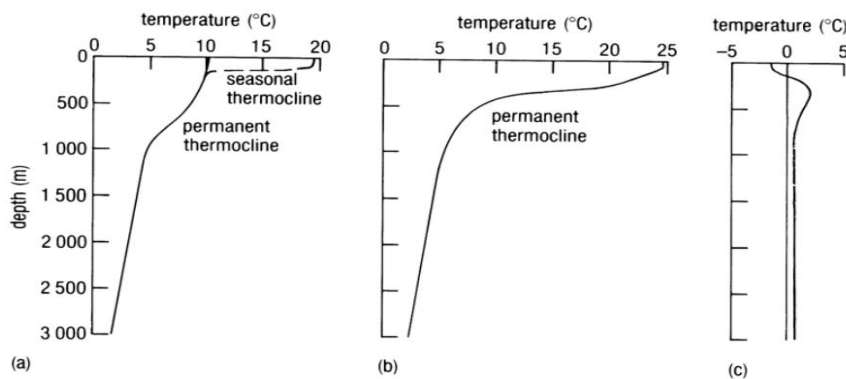
50. A barrier reef is formed

- a. Along the shore of an island.
- b. After the island has completely subsided beneath the surface.
- c. On the surface of exposed guyots.
- d. When the coral is separated from the island by a lagoon.

51. The density of pure water:

- a. Decreases with cooling.
- b. Reaches its maximum at about 4°C.
- c. Does not change with the addition of salt.
- d. Is greater than steel, which is why ships float.

52. Below are profiles of mean ocean temperature with depth at various locations in the ocean. Label a, b, and c with the corresponding latitude (high, low, and mid). Explain your reasoning.



(a) mid latitudes (1 point)

(b) low latitudes (1 point)

(c) high latitudes (1 point)

Explanation: Warm surface water at low latitudes and cold surface water at high latitudes; mid latitudes have a seasonal thermocline. (1 point)

53. Ocean overturning occurs when the:

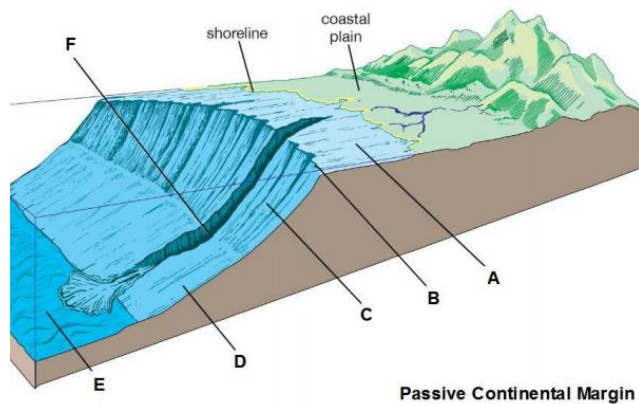
- Water column is isopycnal.
- Density at the surface is less than the density at depth.
- Pycnocline is very pronounced.
- Density at depth is less than the density at the surface.

54. CTD sensors measure which of the following characteristics?

- chlorophyll content
- conductivity
- carbon emissions
- chemicals

55. Label A-F of the features of a passive continental margin.

(1 point each)



A: Continental Shelf

B: Continental Shelf Break

C: Continental Slope

D: Continental Rise

E: Abyssal Plain

F: Submarine Canyon

56. Which of the following is true about the relationships between temperature, salinity, and density?

- Salinity has a greater effect on density than temperature.
- Temperature has a greater effect on density than salinity.
- Temperature and salinity play equal roles in affecting density.
- Neither temperature nor salinity affects density.

57. As a result of Ekman transport, upwelling occurs when:

- Wind blows from the north along the west coast of a continent in the northern hemisphere.
- Wind blows from the south along the west coast of a continent in the northern hemisphere.
- Two surface currents converge.
- Wind blows from the north along the east coast of a continent in the northern hemisphere.

58. If you mix two samples of water with different temperatures and salinities but the same density, you will produce a mixture that has:

- A lower density.
- A higher density.
- The same density as the two samples.
- You cannot predict exactly what will happen.

59. Which of the following is a mixed semidiurnal tidal pattern?

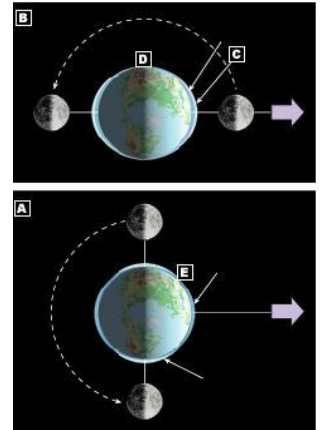
- a. 1 high and 1 low tide per day.
- b. 2 high and 1 low tide per day.
- c. 2 high and 2 low tides of equal height per day.
- d. 2 high and 2 low tides of unequal height per day.

60. Which type of estuary has a strong tidal influence but low river input?

- a. Salt Wedge
- b. Well Mixed
- c. Partially Mixed
- d. Fjord

61. Use the diagram to fill in the blanks with the correct letter (A – E). Not all letters will be used.

- a. Lowest low-tides in the tidal cycle   D
- b. Situation for a spring tide   B
- c. Least difference between high and low tidal ocean surface elevation   E



62. As a tsunami approaches shallow water which of the following set of transformations occur?

- a. Wavelength increases, wave period decreases, and wave height stays the same
- b. Wavelength decreases, wave period decreases, and wave height increases
- c. Wavelength decreases, wave period increases, and wave height increases
- d. Wavelength decreases, waver period stays the same, and wave height increases

63. You have received information that there was an earthquake in Seward, Alaska large enough to produce a tsunami at an ocean depth of 4,000m. Calculate the speed of the tsunami (meters/sec) at this depth. Show all work.

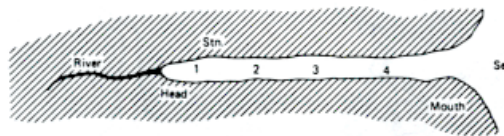
$$S = \sqrt{9.81\text{m/s}^2 * 4,000\text{m}}$$

$$S = \sqrt{39,240\text{m}^2/\text{s}^2}$$

$$S = 198\text{m/s}$$

(up to 4 points)

64. What is an estuary? Identify each type of estuary (well mixed, slightly stratified, highly stratified, salt wedge) using the diagram.



Estuary = body of water where the river meets the sea (1 point)

- a. well mixed (1 point)
- b. slightly stratified (1 point)
- c. highly stratified (1 point)
- d. salt wedge (1 point)

