C - Dynamic Planet - Rickards Invitational Div. C - 12-05-2020

Hello there! Welcome to the Rickards Invitational. You have 50 minutes to complete the following test, good luck!

1. (1.00 pts)
Irvin observes an incoming wave on his radar, and he proceeds to investigate its properties, worried that it could be a tsunami. He receives the following properties about the wave. Use this information to answer questions 1-3. What type of ocean wave is this?

Wave Height	Wave Amplitude	Wavelength	Water Depth (At the given point Irvin records it)
1.0 m	0.5 m	750 m	30 m

- (●) A) Shallow water wave
- ( ) B) Intermediate depth wave
- ( ) C) Deep water wave
- ( ) D) None of the above

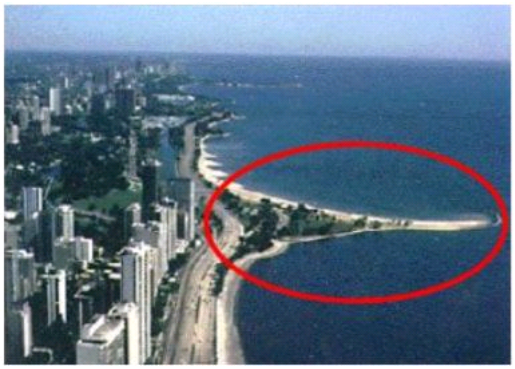
2. (2.00 pts) (2 points) What is the wave celerity in meters per second? Show the formula you used and then the answer.

Expected Answer: They should use √(gd), where d is wave depth, and the answer is about 17.15 m/s. (+1) For showing the formula (+1) For the answer being anywhere between 17.14 to 17.16 m/s

3. (1.00 pts) Should Irvin be worried that this is a tsunami? Explain why using wave speeds as part of your answer.

Expected Answer: No, because a typical tsunami wave has a speed of 200 m/s, while this wave only has 17.15 m/s. Students must have both parts to get this point

4. (2.00 pts) (2 points) Refer to the image below. What object is to the right of the city, and how was it formed?



Expected Answer: This is (any one of the three answers) a cuspate foreland, cuspate barrier, or ness. It forms when two longshore currents in opposite directions merge, forming a triangular extension. It's hard to notice, but there are two curves from two different longshore currents creating that cusp, so that's why I can't accept anything else. (+1) For saying any one of the three: Cuspate foreland, cuspate barrier, or ness (+1) For saying that two longshore currents in opposite directions merged.

5. (1.00 pts) In terms of concentration, what is the fourth most common ion in seawater? If the answer is say Mg2+, type it as Mg2+

Mg2+

6. (3.00 pts)
(3 points) Say there is a continental/continental convergent plate boundary between two plates, and the edges of the crust start to thicken. What will happen to most of this thickened crust, and why?

Expected Answer: By the principle of isostasy, the thickened crust will actually begin to sink. This is because the thickness of the material has increased, and when the material thickens, it actually sinks downwards to compensate for such rather than going up like how an iceberg would. This really is all about isostasy really making more of the edge sink instead of rise. (+1) For saying the crust sinks (+2) For saying that the thickness of the crust increases, and that causes it to sink downwards with isostasy.

7. (1.00 pts) Which of the following relates the least when talking about atolls?

- A) Volcanic island
- B) Guyot
- C) Seamount
- D) Hotspot

8. (1.00 pts)
Let's say that some water has evaporated into the atmosphere near the tropics, and the cloud gets pushed up to about 60 degrees North latitude. Answer questions 8 and 9 using thi information. Which of the following cell(s) transported the cloud? Circle all that apply

(Mark **ALL** correct answers)

- [x] A) Hadley Cell
- [x] B) Mid-Latitude Cell
- [ ] C) Polar Cell

9. (2.00 pts) (2 points) What type of heat was transported during this process? How do you know?

Expected Answer: This is latent heat transport, because the energy was being carried by water going through different phase changes. Water became a gas and held the energy that way until it precipitated, releasing heat into the atmosphere. I'm looking for latent heat because of that evaporation event, but it's fine to have sensible on top of latent. (+1) For saying latent heat (+1) For the explanation that water held and released energy with its phase changes

10. (2.00 pts) (2 points) Identify all of the conditions that Earth needs to be to get the Proxigean Spring Tide. You must get all conditions to get any points.

(Mark **ALL** correct answers)

- [ ] A) 1st/3rd Quarter Moon
- [x] B) Full/New Moon
- [x] C) Perigee
- [ ] D) Apogee
- [ ] E) Diurnal Tide
- [ ] F) Semidiurnal Tide

11. (1.00 pts) Which of the following has the greatest impact on water density?

- (●) A) Temperature
- ( ) B) Salinity
- ( ) C) Pressure
- ( ) D) All of the above have an equal impact

12. (1.00 pts) For questions 12 and 13, use the following image below to answer. What is the circled feature shown below?

Expected Answer: Sea Arch or Natural Arch You can't say Arch.

13. (2.00 pts) (2 points) What will the rock on the right most likely become, and how will it become such?

Expected Answer: The rock on the right will eventually become a sea stack. This is because the waves underneath the sea arch will crash into the rock and crack the rock above, eventually forcing it to collapse and break apart, recessing the headland and creating a sea stack. (+1) For saying it will become a sea stack and not just stack (+1) For saying something similar above (erosion works, too)

14. (4.00 pts) (4 points) What are two major methods that can add salts to seawater, and how does each method work?

Expected Answer: 1. Rock on land will give salts by erosion; since rainwater is slightly acidic, the water takes away the minerals and salts in the rock and runs back down into the ocean with them. 2. Ocean water can go through cracks in the seafloor and start to heat up from magma. Once it does, it will lose the ions it had like sulfates and oxygen and take in magnesium and iron as it comes back up and allows salt formation. 3. Underwater volcanic eruptions can just directly release salts into the ocean. (+1) For identifying any 1 of the 3 methods (+1) For identifying any 2 of the 3 methods (+1) For correctly matching up the first of their two methods with its process (+1) For correctly matching up the second of their tw methods with its process

15. (1.00 pts)
I fire a 30 m/s sound wave directly downwards to see how deep the ocean is. If it took 4.104 minutes for the sound wave to come back up, how deep is the ocean in meters? Have at least 3 significant figures.

Expected Answer: 3600-3700 meters Remember to cut this in half since it took 4.104 minutes to go down and up.

16. (1.00 pts) A longshore current's direction moves _____ relative to the shoreline

- (◉) A) Parallel
- ( ) B) Perpendicular
- ( ) C) Skew
- ( ) D) Diagonally

17. (3.00 pts)
(3 points) Kristin was observing data about certain properties of seawater at various depths, but she forgot to label what each column of data represented in the table below. She remembers that she was measuring temperature, salinity, and density in non-Imperial units. Determine which property matches up with a, b, and c.

Depth (meters)	a)	b)	c)
300	22	1.0262	35
600	11	1.0273	34.4
900	6	1.0279	34.3
1200	5	1.02798	34.5
1500	4.5	1.02798	34.6
1800	4	1.02798	34.7

Expected Answer: a) Temperature (Thermocline) b) Density (Pycnocline) c) Salinity (Halocline) (+1) For each of the three being correctly identified, either as the type of -cline or the property being measured in each.

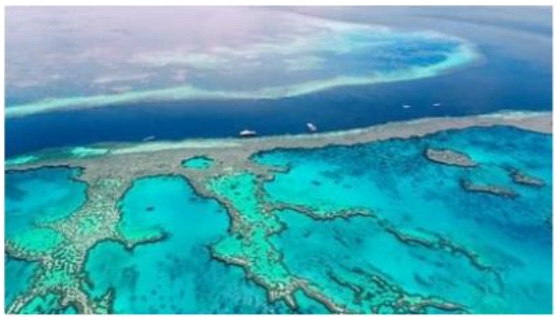
18. (1.00 pts) How does the shape of an ocean wave's orbit change as it comes up toward shore?

Expected Answer: It becomes more elliptical, since it's flattened out from circular to ellitpical.

19. (1.00 pts) Which of the following is least likely going to cause hypoxia at the bottom of the water structure?

- ○ A) Salt-Wedge Estuary
- ◉ B) Well-mixed Estuary
- ○ C) Partially-mixed Estuary
- ○ D) None of the above

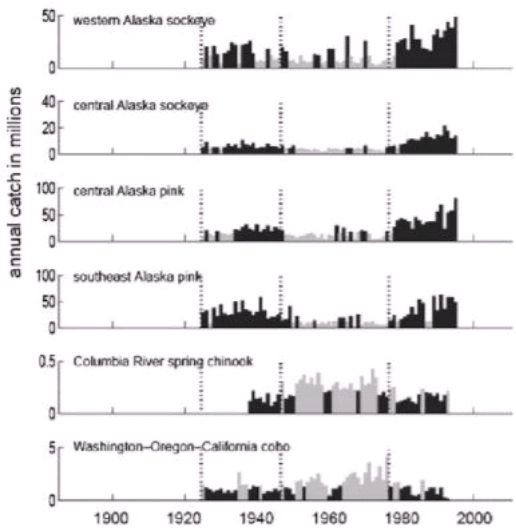
20. (1.50 pts) Identify the type of reef structure shown above. Identifying it exactly will give a bonus 0.5 points.



Expected Answer: Barrier Reef, but Great Barrier Reef will give the students 1.5 points.

21. (2.00 pts) (2 points) Explain how a structure like the one shown above formed.

Expected Answer: A single coral polyp stuck itself onto a rock and kept secreting calcium carbonate to build up its skeletal structure. It kept on repeating this process from there on. (+1) For mentioning coral being involved in such formation (+1) For mentioning calcium carbonate being used to make a growing skeleton ALTERNATIVELY (+1) For mentioning fringing reef (+1) For saying that there is continued build up of coral on edges of dormant volcano/mountain



Above is a chart of the catches of various salmon varieties within the North Pacific Ocean area. The black bars indicate how much more fish were caught than the long-term median i that year, while gray bars indicate how much less fish were caught than the long-term median in that year. Use this information to help guide you in the next few questions.

22. (1.00 pts)
The Aleutian Low would help connect some of the pieces as to why there were fluctuations in salmon production, but what other phenomenon/phenomena is/are linked to this?

- A) El Niño–Southern Oscillation
- B) Madden-Julian Oscillation
- C) Pacific Decadal Oscillation
- D) All of the above

23. (3.00 pts)
(3 points) Whenever the phenomenon/phenomena was/were in an above average temperature phase, so were the amount of salmon being caught. Since this cannot be reasoned with upwelling, suggest why this most likely occurred.

Expected Answer: This depends a lot on the juvenile salmon being able to survive into adulthood. Salmon need a warm area to be able to thrive and grow, so it actually needed a positive PDO for it to grow into greater populations. With more salmon thriving, more could reproduce and thus be caught. (+1) For referring anything about young salmon surviving (+1) For mentioning that the salmon need warm temperatures to thrive (+1) For mentioning that more juvenile salmon allowed a lot more salmon to grow and be caught

24. (2.00 pts)
(2 points) You'll notice that this data starts to disappear around after 1990. In recent years, the phenomenon/phenomena has/have become less useful in predicting whether or not we get a plentiful amount of salmon. What is most likely the ultimate cause of this, and what is its impact?

Expected Answer: The big problem is coming from greenhouse gases. Their excess temperatures are being absorbed by the ocean, causing the ocean to warm up and break down these dramatic patterns with just warm periods. In doing so, PDO and NPGO become less useful indicators of salmon catching. Unfortunately, global warming is not just enough, since that's not specific as to the greenhouse gases being the big hitter on the salmon. (+1) For mentioning greenhouse gases (+1) For mentioning that water is absorbing more heat and causing these cycles to break down.

25. (1.00 pts)
If I were to fire a cannonball from Canada and aimed it directly South, which cardinal direction(s) will apply to the final position of the cannonball relative to the original position? Selec all that apply.

(Mark **ALL** correct answers)

- [ ] A) North
- [x] B) East
- [x] C) South
- [ ] D) West

26. (1.00 pts)
The Bay of Fundy is known for its very unique tides, mainly due to one specific phenomenon. With this phenomenon, the tides become even stronger because the applied force on the tides matches up with the natural frequency of the wave. What is the phenomenon called?

Expected Answer: Tidal Resonance

27. (1.00 pts) What gradients usually affect Deep Ocean Circulation?

Expected Answer: Temperature and Density/Salinity (+0.5) For each of the two correctly identified

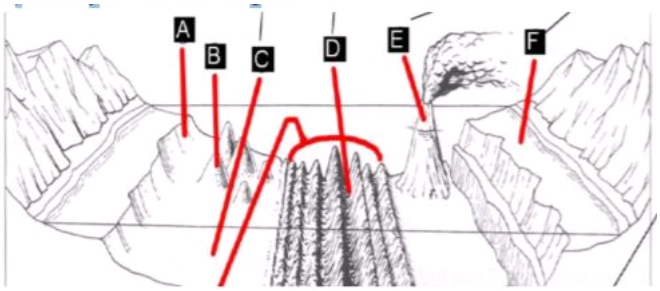
28. (1.00 pts) What is the part of a CTD that actually collects water for sampling?

Expected Answer: Niskin/Nansen Bottles No, the rosette sampler is not that part that has the bottles, which are the things collecting water.

29. (1.00 pts) I let a corer fall into the ground, but I didn't really get a viable enough sample with this corer. What corer should I try to use instead?

- A) Gravity corer
- B) Piston corer
- C) Box corer
- D) None of the above will do better than the original corer

30. (3.00 pts) (3 points) Identify A-F on this diagram



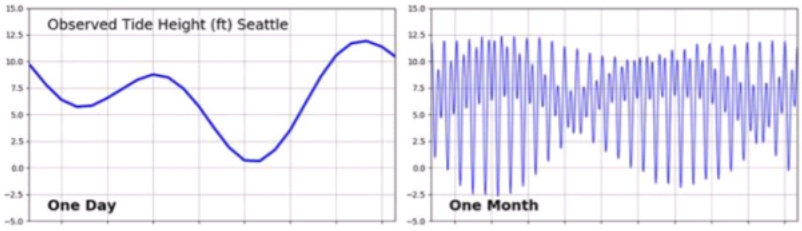
Expected Answer: a) Continental Slope b) Seamount c) Abyssal Plain d) Rift Valley/Mid Ocean Ridge e) Volcanic Island (Volcano is okay, but if you add underwater, that's clearly wrong based on the image) f) Continental Shelf (+0.5) For each one of the following being correctly identified

31. (2.00 pts) (2 points) Classify each of the following causes and if they primarily affect relative or eustatic sea level changes.

a) Ice Age
b) Land subsidence
c) Thermal expansion of water
d) Tectonic Plate formation

Expected Answer: a) Ice Age Eustatic b) Land subsidence Relative c) Thermal expansion of water Eustatic d) Tectonic Plate formation Eustatic (+0.5) For each of the following bein correctly classified

32. (1.00 pts)



Above is a graph of the tides at Seattle, Washington over two different time frames. Use this data to answer the next two following questions. What kind of tide pattern does it have?

- A) Diurnal
- B) Semidiurnal
- C) Mixed
- D) None of the above/it cannot be determined

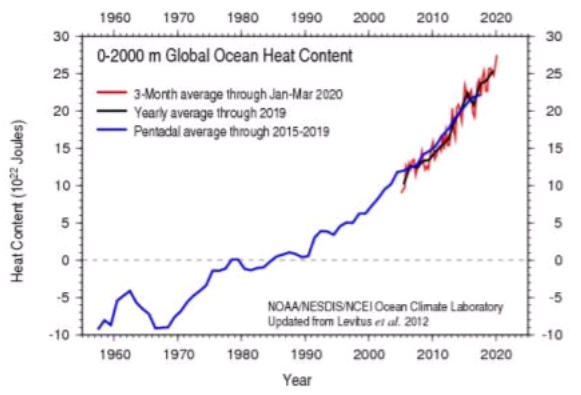
33. (1.00 pts) How many full moons did Seattle experience during a month?

- A) 0
- B) 1
- C) 2
- D) 4
- E)

34. (2.00 pts)
(2 points) 570°C is an important temperature for oceanographers when determining ages of oceanic crust. What is the name for this specific temperature and why is it so important?

Expected Answer: This is the Curie temperature, known for being the temperature at which magnetic materials lose magnetic properties. Because they lose such magnetic properties, they can swap their polarities along with any magnetic reversals Earth may encounter, and we can track the ages of the crust with it once the material cools and keeps a permanent magnetic polarity. (+1) For mentioning the Curie temperature (+1) For explaining that the magnetic materials lose permanent magnetic polarities at that temperature

35. (1.00 pts)



Above is a graph of the global ocean heat content over time. Use this to answer the next three questions. Looking at this, what single word term best explains how the ocean is storing this heat?

Expected Answer: Enthalpy

36. (1.00 pts) Give the two major molecules that are involved in this rise in global ocean heat content

Expected Answer: CO2 and CH4 (CO2 and CH4 are also okay)

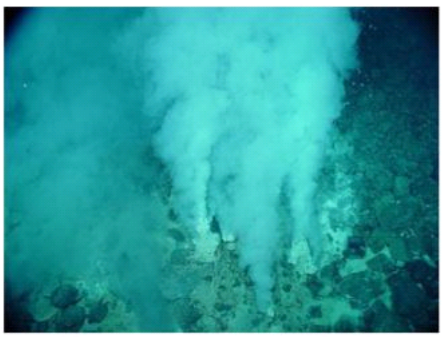
37. (2.00 pts) (2 points) Does this rise in heat content benefit or harm coral? Why?

Expected Answer: This does NOT benefit coral, because the excessively high temperatures cause coral to expel the algae that they need to survive. (+1) For saying that the rise in heat content hurts the coral (+1) For mentioning coral bleaching or describing the phenomenon listed above

38. (2.00 pts)
(2 points) Tammy is swimming near a beach within the Gulf of Mexico when she suddenly feels a strong force pulling her away to sea. She's struggling to swim against this mysterious force. What's going on, and is there a way that she can save herself before imminent demise?

Expected Answer: Tammy got caught in a rip current, which is a narrow channel of fast moving water going back into the ocean. Tammy should not fight the current itself, but she should rather swim parallel to it to break free and then swim back to safety. (+1) For mentioning either a rip current or the definition of such (+1) For saying that Tammy should swim parallel to the direction of the rip current

39. (1.00 pts)



Use the image above to help answer questions 39 and 40. Where are you most likely going to find an object like this?

- ○ A) Convergent Plate Boundary
- ○ B) Transform Plate Boundary
- ◉ C) Divergent Plate Boundary
- ○ D) Passive Margin

40. (1.00 pts) What does this object produce that helps with ocean circulation?

Expected Answer: Hot water is being ejected into the cold bottom of the ocean.

41. (1.00 pts) In those movies where you see surfboarders riding a wave while water is flying over them, what kind of breaking wave are you most likely observing?

- ○ A) Spilling Breaker
- ○ B) Surging Breaker
- ○ C) Collapsing Breaker
- ◉ D) Plunging Breaker

42. (1.00 pts) There are 4 main ways that a tsunami can be caused. Name 2 of them

Expected Answer: Earthquakes, Landslides, Volcanic Eruptions, and Meteor Crashes (+0.5) For each one successfully named, but do not give more than 1 point in total for this question.

43. (2.00 pts)
(2 points) As our technology advances, we are currently finding ways to keep more people safe from catastrophic events. We have now created the DART system to help us with one of these events. What event is the DART system used for, and describe the parts that comprise it?

Expected Answer: It helps us deal with tsunamis, and it utilizes a buoy at the top of the ocean as an alarm and a seismic activity/water pressure sensor. (+1) For correctly identifying the catastrophic event as a tsunami (+0.5) For mentioning a buoy that is an alarm (saying just buoy is okay here) (+0.5) For mentioning a sensor at the bottom of the ocean that can track seismic activity and water pressure (Do not give credit if they just say a sensor since they should explain)

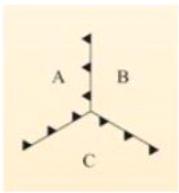
44. (1.50 pts) (1.5 points) Of the seven colors of the rainbow, which ones could you see below 100 meters of the sea level surface?

Expected Answer: Green and blue (+0.5) For listing one color correctly (+1) For listing the second color correctly while also having listed no other colors

45. (1.00 pts) How could surface winds help with upwelling?

Expected Answer: Surface winds will push the water beyond the shore, creating an open area for cold, nutrient-rich water to come up and fill in the missing space.

46. (1.00 pts)



Examine the triple junction of plate tectonics here. Are the odds that this type of triple junction is going to be stable higher or lower than that of a RRR triple junction?

Expected Answer: It's probably going to have lower odds of being stable compared to an RRR triple junction, as a TTT triple junction usually is not stable

47. (1.50 pts) (1.5 points) Rank the order of the amount of crust that each of the lettered plates will lose in decreasing order

Expected Answer: B, C, and then A (+0.5) For each letter being in its correct position of B,C,A

48. (2.00 pts)
(2 points) I was on a flight that went from California to Kuroshio, but as I was flying, I managed to spot two large patches of garbage along the way. What is keeping the garbage from separating, and how is it doing such?

Expected Answer: The North Pacific Gyre is holding in the garbage so that it doesn't escape, and it holds the garbage in its vortex by creating a circular current that will prevent the escape of any piece of garbage once stuck inside. (+1) For identifying the North Pacific Gyre (0.5 for saying gyres in general, since I did mention my flight path such that I could have only witnessed one of the gyres in action) (+1) For saying that the garbage gets trapped in the circular current

49. (1.00 pts)

Use this image for questions 49 and 50. This is an image of what in South Wales, UK?

Expected Answer: Wave-cut/Wave-carved Platform

50. (2.00 pts) (2 points) Explain how there is such a steep elevation gradient by explaining how such an object forms.

Expected Answer: The destructive waves erode the rock that is at the same elevation as the waves and then create a notch. This notch slowly expands with more erosion until the rock above cannot be upheld and thus all collapses down. (+1) For mentioning a notch being formed near the height of the wave or erosion (+1) For mentioning that the rock directly above will eventually collapse and cause the steep elevation change that way.

51. (2.00 pts) (2 points) Explain why in an Ekman spiral, the water moves in various different directions.

Expected Answer: At certain depths, water will move in one particular direction based onthe wind/water above the layer and then Coriolis force pushes the water perpendicularly to the direction of the wind/water above. Because Coriolis force always keeps to a 90 degree angle, it will keep turning the motion of the water. (+1) For mentioning that the wind/water above will impact some of the water below it (+1) For mentioning how Coriolis force always keeps to a 90 degree angle (angle must be identified) with the direction of the wind/water above the layer the force current “acts” on

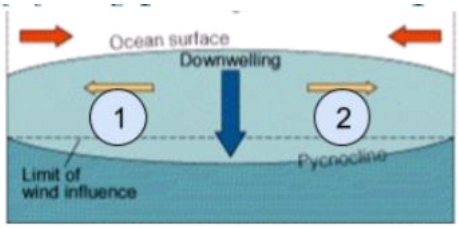
52. (2.00 pts) (2 points) In gyres, some water is elevated up higher than other chunks of water, yet gravity can’t seem to push it back down. Why is this the case?

Expected Answer: The Coriolis force is actually acting so much more powerfully than gravity, and when this happens, the water will actually start spinning around in the direction of the gyre since gravity cannot overtake it and push it downwards. (+1) For explaining that Coriolis force overrides the force of gravity (+1) For saying that the water spins in the direction of the gyre to uphold its vertical position

53. (2.00 pts) (2 points) If Ekman Suction occurs at a certain area in the ocean, what happens to the thermocline and the sea surface elevation at the area of upwelling?

Expected Answer: The thermocline goes upward as the water gets sucked out and the sea surface elevation there depresses. (+1) For saying that the thermocline goes upward (+1 For saying the sea surface elevation goes downward

54. (1.00 pts)



Examine this diagram for questions 54 and 55. What kind of Ekman transport is this?

Expected Answer: Ekman Pumping

55. (1.00 pts) If this is an image in the Northern Hemisphere, is the geostrophic current moving toward us from 1 or 2, and how do you know?

Expected Answer: 2, because the pressure gradient wants to move downwards from a high to low elevation, but the Coriolis effect will push it back upwards at a 90 degree angle CLOCKWISE, so for it to do so, 2 needs to be pointing toward us.

Congratulations on finishing! Don't forget to check your answers. Once you do, feel free to submit. Good luck on your other events!