

Captains Tryouts: Dynamic Planet Test

Northwood High School

You will have 50 minutes to complete this test. Good luck!

Names:

School:

Team Number: #

Score: KEY/112

1. Who proposed the theory of atoll formation? Name the four major components/steps. (5 points)
 - Charles Darwin (1 point)
 - Starts with a volcanic island which becomes extinct (1 point)
 - Island/ocean floor subsides, coral growth builds fringing reefs, often with a shallow lagoon between the land and the main reef (1 point)
 - Subsidence continues, fringing reef grows into a larger barrier reef farther from shore with a bigger, deeper lagoon inside (1 point)
 - Island sinks below the sea, barrier reef becomes an atoll enclosing an open lagoon (1 point)

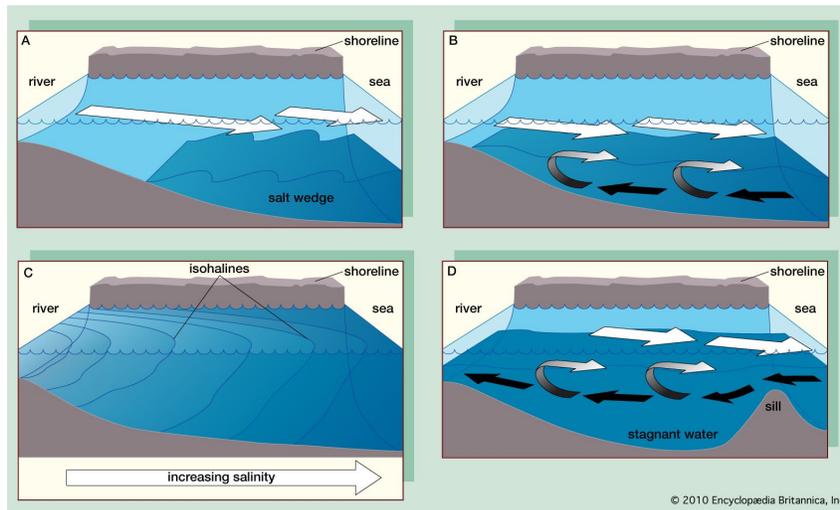
2. Explain what patch reefs are and their ecological role. (2 points)
 - Small, isolated reefs, grow from open bottom of the island platform or continental shelf (1 point)
 - Good nurseries, provide hiding places for young fish, biomass for consumption and growth (1 point)

3. Describe the level of productivity found in the neritic zone. (2 points)
 - Primary productivity is high (1 point)
 - Plankton/zooplankton/small organisms support the bottom of the food webs/fisheries (1 point)

4. How do longshore currents form? (3 points)
 - Waves move toward the beach, different segments encounter some before others (1 point)
 - Waves bend/conform to the parallel of the beach→ arrive at a slight angle (1 point)
 - Wave reaches the beach, provides a burst of energy that generates the longshore current, which runs parallel to the beach (1 point)

5. How are estuaries classified based on geomorphology? (4 points)
 - Drowned river valley/coastal plain estuary/ria (1 point)
 - Lagoon-type/bar-built (1 point)
 - Fjord-type (1 point)
 - Tectonically produced (1 point)

6. Label A-D with their corresponding estuary types and describe each one. (8 points)



- A: salt wedge (1 point), minimal mixing, salt water wedge thickest at the seaward end (1 point)
- B: partially mixed (1 point), tides create turbulence and allow for mixing (1 point)
- C: vertically homogeneous (1 point), river flow is weak, tidal flow is strong, no stratification occurs (1 point)
- D: fjord (1 point), originally formed by a glacier, submerged ridge/sill near the mouth of glacial deposits (1 point)

7. What is the CCD and what is the average value? (3 points)

- Calcite/carbonate compensation depth (1 point)
- Depth at which the rate of supply of calcium carbonate lags behind the rate of solution (1 point)
- Around 4200-4500 m in the Pacific Ocean (1 point)

8. What is the ecological impact of downwelling and how does it form? (2 points)

- Surface waters converge, push water downwards (1 point)
- Regions with downwelling have low productivity because the nutrients in the water column are not continuously resupplied (1 point)

9. What is the role of thermohaline circulation in regulating global climate? (2 points)

- Allows energy to be transferred between the tropics and the poles (1 point)
- Prevents extreme fluctuations in ocean temperature (1 point)

10. How does an Ekman spiral form? (2 points)

- Formed when wind moves surface water molecules in one direction, causing it to drag deeper layers of water molecules beneath them. A rotating column of water, the spiral, forms when these winds pull the water at an angle, due to the Coriolis Effect (2 points)

11. What are gyres and how do they form? (2 points)

- Gyres are systems of large circular/rotating ocean currents (1 point)

- Circular rotation formed by the Coriolis effect → due to the planet's rotation → deflection of wind (1 point)

12. What is the global significance of the existence of AABW? (2 points)

- The AABW is the Antarctic Bottom Water, a cold and dense water mass in the Southern Ocean surrounding Antarctica (1 point)
- As the coldest bottom water, it has an important role in the circulation and movement of the world's oceans (ie. thermohaline circulation, etc.) (1 point)

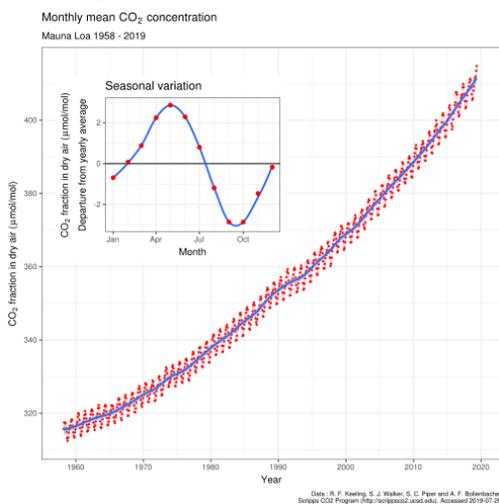
13. Why is the ocean salty? List and describe three sources of salts. (2 points)

- The ocean contains many dissolved ions (sodium, chloride, etc.) (1 point) that can come from sources such as runoff from streams/ivers, erosion of rock due to carbonic acid rain, submarine volcanism, and hydrothermal vents that contribute dissolved minerals to the oceans (1 point).

14. Typically, saltier water is found in deeper layers of the ocean. Identify where on Earth this is not the case and explain why it occurs. (2 points)

- Areas in subtropical latitudes experience high salinities near the sea surface since there is high surface evaporation and lower precipitation rates (1 point for identification, 1 point for explanation)

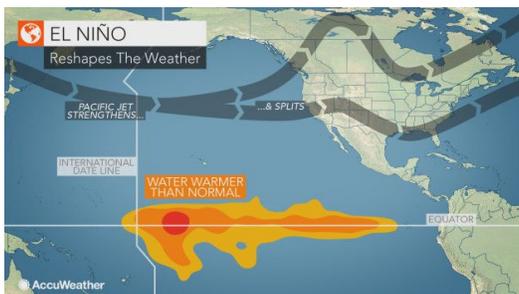
15. Interpret the Keeling curve and the effects the trend depicted has had on the ocean's chemistry. (3 points)



- The graph shows an overall increase in carbon dioxide in the atmosphere (1 point)
- As atmospheric carbon dioxide levels rise, the ocean absorbs more and more carbon dioxide, which increases ocean acidification (1 point) by producing carbonic acid/hurting marine organisms that need CaCO₃ deposits for shells/coral (1 point)

16. What are the top five most common dissolved ions in seawater? What is the average salinity in parts per thousand (ppt)? (6 points)

- Sodium (Na^+), Chloride (Cl^-), Sulfate (SO_4^{2-}), Magnesium (Mg^{2+}), and Calcium (Ca^{2+}) (5 points, 1 point each)
 - Average salinity: 35 ppt (1 point)
17. Explain the Marquet Principle. Which ions carry slight exceptions to this rule? (2 points)
- The Marquet Principle states that regardless of varying salinities, the major elements in seawater are present in constant proportions to each other (1 point)
 - Slight exceptions include HCO_3^- (<20%), Ca^{2+} (<1%) and Sr^{2+} (<2%) (1 point)
18. Define residence time. Which elements tend to have longer ones in the ocean? Shorter ones? (2 points)
- Residence time is how long a substance remains in a given reservoir, such as the ocean (1 point)
 - Sodium and chloride have long residence times in the ocean (1 point), while elements like calcium have relatively shorter residence times (1 point)
19. What is thermal expansion and the implications it has on sea levels? (2 points)
- The ocean absorbs a lot of trapped heat due to the greenhouse effect in the atmosphere, and the warming of the ocean causes water to expand (water volume will rise) (1 point)
 - Responsible for thermosteric sea level rise; contributed 42% to sea level rise from 1993 to 2018. Thermal expansion will continue to increase sea levels by estimates of around 0.6 millimeters per year. (1 point)
20. El Niño has significant impacts on ocean water temperature. Explain how these temperature fluctuations play a role in South America's economy. (2 points)



- With more intense episodes of El Niño occurring due to global warming, South America will continue to see more severe droughts with less than normal rainfall, which will result in losses in agricultural production and exports for the economy.
 - Other implications include more floods, wildfires in certain areas, and losses in the fishing industry (2 points: 1 point for each implication)
21. How does tidal resonance occur? (2 points)
- Tide excites one of the resonant modes of the ocean (1 point)
 - Incident tidal wave can be reinforced by reflections between coast and continental shelf's edge, creating a higher tidal range at the coast (1 point)

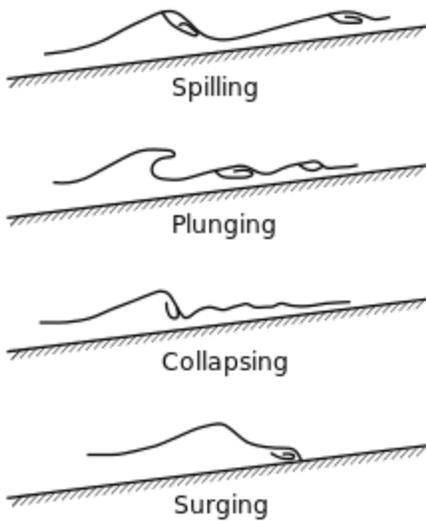
22. What is significant about the Bay of Fundy in terms of oceanography? (1 point)

- Exhibits one of the highest tidal ranges in the world (1 point)

23. Wave height is affected by three main factors. List and describe them. (3 points)

- (½ point for name, ½ point for explanation)
- Wind speed: slower wind speeds produce smaller waves
- Wind duration: longer durations increase height
- Fetch: larger fetch generates larger waves

24. What are the four types of breaking waves? Draw a diagram for each one. (5 points)

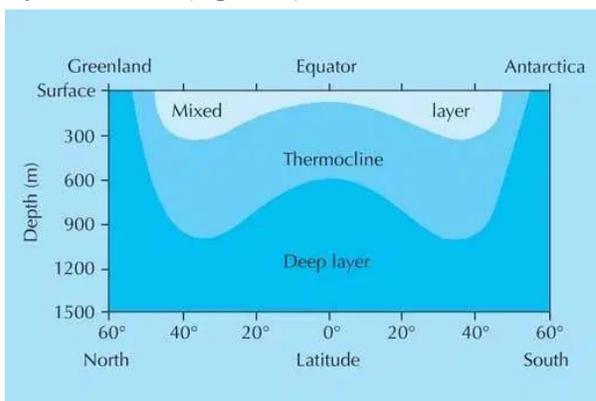


(1 point for each name, 1 point for the entire diagram)

25. Differentiate between how spring and neap tides are formed. (2 points)

- Spring tides form during the new and full moon (1 point)
- Neap tides form when the sun and moon are at right angles with each other (1 point)

26. Draw a simplified diagram of the three-layer structure of ocean water. Explain what each of the layers means. (4 points)



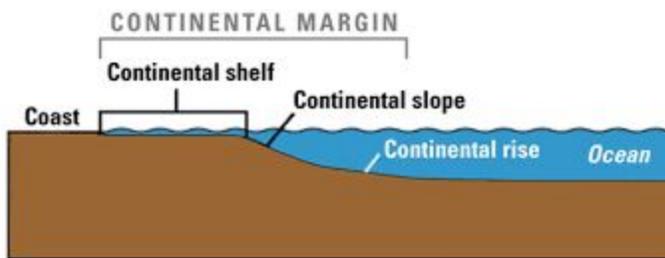
(1 point for diagram)

- Mixed layer: the surface layer, tends to be warmest layer due to heating from the sun (1 point)
- Thermocline: transition layer that separates the warm surface water from the cold, deep ocean layer (1 point)
- Deep layer: also known as the deep ocean, is where water is cold and dense, water temperature and salinity tend to remain relatively constant below the thermocline (1 point)

27. What drives deep ocean circulation? (1 point)

- Density differences between water bodies (1 point)

28. Draw a diagram of a continental margin, labelling the continental shelf, continental slope, continental rise, and submarine canyon. Then, explain the characteristics of each of these four features. (4 points)



(1 point for diagram)

- Continental shelf: closest to the shore and serves as the transition to the ocean and is relatively flat (1 point)
- Continental slope: steep sloping edge that merges into the deep ocean basin, separated from the continental shelf by a shelf break (1 point)
- Continental rise: depositional feature of sediment that accumulates at the base of slope, slope decreases as it nears toward the ocean floor (1 point)

29. What are the two types of continental margins and how can they be differentiated? (3 points)

- (½ point for each name, 1 point per explanation)
- Active: narrow, tectonically active, ex. West Coast of North America
- Passive: generally wider, more sediment deposits, not tectonically active, ex. East Coast of North America

30. What is an abyssal plain? How much of Earth's surface is taken up by these (approximately)? (2 points)

- Abyssal plains are large, flat regions of the ocean floor between the continental rise and mid-ocean ridge (1 point)
- They take up over 50% of the Earth's surface (1 point)

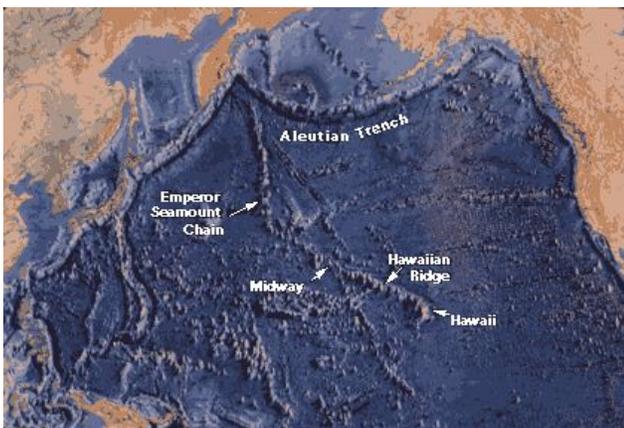
31. Describe how abyssal fans form. Explain how the Bouma Sequence helps to explain how this process is driven. (2 points)

- Formed when currents push sediment from the continental shelf down the continental slope, which forms a submarine fan which extends slowly until it reaches the ocean bed (1 point)
- The Bouma Sequence explains how deposition occurs as turbidity currents move downslope, the flow of such currents lose energy as the encounter changes in the slope as they travel down the slope. It is responsible for the series of graded sediments of sand, silt, mud, etc. (turbidites) that forms (1 point)

32. What is the difference between a seamount and guyot? (1 point)

- A guyot is a type of seamount with a flattened top, hence the name tablemount (1 point)

33. The Hawaiian-Emperor Seamount Chain is located in the Pacific Ocean. Given the map below, in what direction does the Pacific Plate appear to move? (2 points)



- Northwesterly direction (2 points)

34. What is a dredge used for in oceanography? (1 point)

- Used to collect rock/sediment samples from the ocean bottom (1 point)

35. How does a box corer work and what samples does it typically collect? (2 points)

- Collects soft sediments from lakes/oceans (1 point)
- Depth pinger/indicator used to determine if the box is filled with sediment, then a spade is moved over the bottom to close the box, which can be safely brought to the surface (1 point)

36. What role does the ocean play in regulating shortwave and longwave radiation, and what global impacts does it have? To answer this question fully, please include descriptions of these radiations and examples. (4 points)

- Incoming solar radiation is shortwave radiation (visible, UV, infrared) (1 point)
- Solar energy that is absorbed by the earth is emitted as longwave radiation, which warms the lower atmosphere (1 point)
- Water's high specific heat capacity allows the ocean to absorb more energy without as drastic an increase in temperature as seen in the atmosphere, thereby helping to control climate (1 point)

- However, increases in the amount of longwave radiation trapped by the atmosphere means that it is harder for the ocean to regulate climate (1 point)
37. Why is the ocean blue? (2 points)
- Ocean water absorbs longer wavelength light (red, orange, yellow) more strongly than shorter wavelength light such as blue, which gets reflected back (2 points)
38. Explain the two main types of hydrothermal vents and how they differ chemically and physically. (2 points)
- Black smokers: hottest of all hydrothermal vents, spews out primarily sulfide and iron, minerals precipitate upon release, causing visible “black” smoke (1 point)
 - White smokers: smaller in size, releases cooler water, releases minerals that are not metals (1 point)
39. Name and describe three of the major marine sediment types. Give examples and sources for each. (9 points)
- Lithogenous: small particles from weathered rock and oceanic volcanic sediment
 - ie. volcanogenic sediments, glacial marine sediments, abyssal clays
 - Biogenous: remains of dead organisms
 - ie. remains from shellfish, clams, etc.
 - Hydrogenous: precipitation of dissolved minerals in water
 - ie. evaporites, manganese nodules, oolites, etc.
 - Cosmogenous: particles like dust and meteorite fragments, from outer space
 - (3 points per sediment type: 1 point for naming, 1 point for explaining, 1 point for example/naming sources)
40. What are marine transgression and regression? (2 points)
- Marine transgression: when sea levels rise relative to land and the shoreline moves to higher land, causing events such as flooding which cover previously exposed land (1 point)
 - Marine regression: when areas of submerged seafloor are exposed above the sea level due to relative sea-level fall (1 point)