

Depthquest — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Depthquest.

Write in the book, circle your answers, and check the Answer Key at the back.

1. Ocean Zones & Layers

Circle the correct answer

1. What is the name of the ocean zone that receives the most sunlight?
(A) Abyssal zone (B) Midnight zone (C) Sunlight zone (epipelagic) (D) Twilight zone
2. How deep does the sunlight zone extend below the ocean surface?
(A) About 4,000 meters (13,100 feet) (B) About 1,000 meters (3,300 feet) (C) About 200 meters (660 feet) (D) About 50 meters (165 feet)
3. What is the twilight zone of the ocean also called?
(A) Bathypelagic zone (B) Hadal zone (C) Mesopelagic zone (D) Epipelagic zone
4. Which ocean zone has absolutely no sunlight at all?
(A) Continental shelf zone (B) Twilight zone (C) Sunlight zone (D) Midnight zone (bathypelagic)
5. Why can plants only grow in the sunlight zone of the ocean?
(A) Because there are no nutrients in deeper water (B) Because the water pressure crushes all plants below 200 meters (C) Because the water is too salty in deeper zones (D) Because plants need sunlight for photosynthesis, which only reaches the top 200 meters
6. What happens to water pressure as you go deeper in the ocean?
(A) Water pressure increases (B) Water pressure disappears completely (C) Water pressure decreases (D) Water pressure stays the same

Write the answer

7. Why is the deep ocean cold even in tropical regions?
Answer: _____
8. How does the twilight zone differ from the midnight zone in terms of light?
Answer: _____
9. Why do many twilight zone animals have large eyes?

Answer: _____

10. What is the deepest zone of the ocean called?

Answer: _____

Match each question to its answer

1. A scientist finds an organism at 500 meters depth. Which ocean zone is the organism in? →
2. If you placed ocean zones in order from shallowest to deepest, which would be the correct sequence? →
3. A deep-sea fish has bioluminescent organs. Which ocean zone is it most likely adapted to? →
4. Using what you know about ocean zones, predict what would happen to a surface fish if it swam down to the abyssal zone. →
5. A research submarine finds a thriving ecosystem of tubeworms and shrimp near a deep-sea vent at 3,000 meters. Why can life exist here without sunlight? →

- (A) Sunlight, Twilight, Midnight, Abyssal, Hadal
 - (B) It would likely not survive due to extreme pressure, cold, and darkness
 - (C) Midnight zone or deeper, where there is no sunlight
 - (D) Twilight zone (mesopelagic)
 - (E) Organisms use chemical energy from the vent instead of sunlight
-

2. Marine Life & Habitats

Circle the correct answer

11. What type of marine organism produces most of the oxygen in Earth's atmosphere?
(A) Seaweed forests (B) Coral reefs (C) Phytoplankton (D) Whales
12. What is the name for the area where a river meets the ocean?
(A) Estuary (B) Reef (C) Trench (D) Delta
13. Which marine mammal is the largest animal ever known to have lived on Earth?
(A) Blue whale (B) Giant squid (C) Great white shark (D) Orca (killer whale)
14. What is a group of kelp growing together in the ocean called?
(A) Kelp reef (B) Kelp forest (C) Kelp colony (D) Kelp meadow

15. Why do many marine organisms living in the open ocean have a blue or transparent body?

(A) Because the cold temperature turns them blue (B) To camouflage themselves in the blue open water where there is no place to hide (C) Because blue water makes all organisms change color (D) Because they eat blue-colored food

16. How are marine food chains different from land food chains?

(A) Marine food chains are shorter than land food chains (B) Marine food chains do not need the sun (C) Marine food chains do not have predators (D) Marine food chains often start with microscopic phytoplankton instead of large plants

Write the answer

17. Why are estuaries considered important nursery habitats for many fish species?

Answer: _____

18. What role do mangrove trees play in coastal marine habitats?

Answer: _____

19. Explain why sea otters are considered a keystone species in kelp forest ecosystems.

Answer: _____

20. How do clownfish and sea anemones help each other in their relationship?

Answer: _____

Match each question to its answer

1. A marine biologist observes that after a storm destroyed a large section of mangroves, the nearby fish population decreased. Using your knowledge of habitats, explain why this happened. →

2. You discover a marine organism with the following features: a hard shell, eight legs, and two large claws. Based on these characteristics, which group does it most likely belong to? →

3. A new species of seabird starts nesting on an island, and its droppings wash into the surrounding waters. How might this affect the marine ecosystem nearby? →

4. If you wanted to find the greatest variety of marine species in a small area, which habitat would you choose to explore? →

5. Using the ocean food chain (phytoplankton > zooplankton > small fish > tuna > shark), predict what would happen if a disease killed most of the zooplankton. →

- (A) Crustaceans (such as crabs or lobsters)
 - (B) The droppings add nutrients to the water, which can increase phytoplankton growth and support more marine life
 - (C) Coral reef
 - (D) The mangroves provided nursery habitat and shelter; without them, young fish lost protection and food sources
 - (E) Small fish populations would decline from lack of food, causing a chain reaction affecting tuna and shark populations too
-

3. Ocean Currents & Tides

Circle the correct answer

- 21.** What is the primary force that drives surface ocean currents?
(A) Wind (B) Underwater volcanoes (C) The moon's gravity (D) The rotation of the Earth alone
- 22.** What is the name of the warm ocean current that flows from the Gulf of Mexico northward along the eastern coast of the United States?
(A) The Antarctic Circumpolar Current (B) The Gulf Stream (C) The California Current (D) The Humboldt Current
- 23.** What causes ocean tides?
(A) The spinning of whirlpools (B) The gravitational pull of the moon and, to a lesser extent, the sun (C) Heat from underwater volcanoes (D) Wind blowing across the ocean
- 24.** How many high tides does most of Earth's coastline experience in a 24-hour period?
(A) Two (B) Four (C) Six (D) One
- 25.** How does thermohaline circulation differ from wind-driven surface currents?
(A) Thermohaline circulation is driven by differences in water density caused by temperature and salinity, not wind (B) Thermohaline circulation is faster than surface currents (C) Thermohaline circulation only moves water horizontally, not vertically (D) Thermohaline circulation only happens in freshwater lakes
- 26.** Why does the Coriolis effect cause ocean currents to curve to the right in the Northern Hemisphere?
(A) Because the Northern Hemisphere has more land masses blocking the water (B) Because Earth's rotation deflects moving water to the right in the Northern Hemisphere (C) Because water is warmer in the Northern Hemisphere and moves faster (D) Because the moon's gravity is stronger in the Northern Hemisphere

Write the answer

27. Explain why spring tides produce higher high tides and lower low tides than neap tides.

Answer: _____

28. How do ocean currents help regulate Earth's climate?

Answer: _____

29. Why does upwelling bring nutrient-rich water to the surface, and why is this important for marine life?

Answer: _____

30. What is the 'great ocean conveyor belt'?

Answer: _____

Match each question to its answer

1. The west coast of South America has productive fishing grounds. Based on your knowledge of ocean currents, which process is most responsible for this productivity?

→

2. A sailor in the Northern Hemisphere throws a message in a bottle into the ocean. If it enters the North Atlantic gyre, which direction will it travel? →

3. A coastal community is planning where to build a new harbor. Using your understanding of tides, why should they study tidal ranges before choosing a location? →

4. During an El Nino event, the trade winds weaken. Predict what happens to the upwelling along the coast of South America. →

5. If you placed a floating sensor in the ocean near the equator, would the Coriolis effect be strong or weak at that location? Explain why. →

(A) Upwelling decreases because weaker winds move less surface water away from the coast, so less deep water rises

(B) Upwelling along the coast brings nutrient-rich deep water to the surface

(C) Large tidal ranges could leave boats stranded at low tide or flood docks at high tide, affecting harbor operations

(D) Weak -- the Coriolis effect is weakest at the equator and strongest at the poles

(E) Clockwise, circling the North Atlantic Ocean

4. Coral Reef Ecosystems

Circle the correct answer

31. Are corals plants, animals, or rocks?

(A) Rocks (B) Animals (C) Plants (D) Fungi

32. What is the name of the tiny algae that live inside coral tissue and give corals their color?

(A) Zooxanthellae (B) Kelp spores (C) Phytoplankton (D) Diatoms

33. What percentage of all marine species are estimated to live on or around coral reefs?

(A) About 5% (B) About 75% (C) About 25% (D) About 50%

34. What is the largest coral reef system in the world?

(A) The Caribbean Reef in Florida (B) The Hawaiian Reef in the Pacific (C) The Great Barrier Reef in Australia (D) The Red Sea Reef in Egypt

35. Why do coral reefs need clear, shallow water to thrive?

(A) Zooxanthellae algae inside corals need sunlight for photosynthesis, which requires clear water for light penetration (B) Murky water is too heavy for coral structures to support (C) Corals feed on surface debris that only exists in shallow water (D) Corals breathe air and need to be close to the surface

36. What happens during coral bleaching?

(A) Sunlight bleaches coral like it bleaches hair (B) Stressed corals expel their zooxanthellae algae, turning white and losing their primary food source (C) Corals are painted white by ocean chemicals (D) Corals grow a white protective coating for defense

Write the answer

37. How do coral polyps build the hard reef structure that we see?

Answer: _____

38. Explain the relationship between parrotfish and coral reef health.

Answer: _____

39. What are the three main types of coral reef formations?

Answer: _____

40. Why are coral reefs important to humans beyond their ecological value?

Answer: _____

Match each question to its answer

1. A marine biologist notices that a reef has turned mostly white after a summer heat wave. What is happening, and what should they monitor to assess whether the reef will recover? →
2. An island's government is considering allowing a resort to be built over a section of coral reef. Using your knowledge of reef ecosystems, what environmental impact assessment would you recommend? →
3. Scientists discover a species of coral that can survive in slightly warmer water than most corals. How could this discovery be applied to coral reef conservation? →
4. A fish species on a coral reef changes sex from female to male as it grows larger. How does this adaptation benefit the population? →
5. If you were designing a marine protected area around a coral reef, what factors would you consider when deciding the boundaries? →

(A) It ensures there are always breeding pairs available, as the largest fish become males to defend territory while smaller females produce eggs

(B) Include the reef itself plus surrounding seagrass beds and mangroves that serve as connected nursery habitats, and protect upstream areas from pollution runoff

(C) Heat-tolerant corals could be used to reseed damaged reefs, creating more climate-resilient reef communities

(D) Assess damage to reef biodiversity, loss of coastal storm protection, impact on local fisheries, sediment runoff effects, and long-term economic value of the intact reef

(E) The reef is bleaching from heat stress; they should monitor water temperature and whether zooxanthellae return to corals within weeks

5. Deep Sea Exploration

Circle the correct answer

41. What is the deepest known point in the ocean?

(A) The Puerto Rico Trench (B) The Challenger Deep in the Mariana Trench (C) The Java Trench (D) The Tonga Trench

42. What is the process called when organisms produce their own light in the deep sea?

(A) Chemosynthesis (B) Bioluminescence (C) Photosynthesis (D) Fluorescence

43. What type of underwater vehicle is designed to carry humans to extreme ocean depths?

(A) Sonar buoy (B) Bathythermograph (C) Submarine (D) Submersible (or bathyscaphe)

44. What are hydrothermal vents?

(A) Natural tunnels that connect different ocean basins (B) Openings in the ocean floor where geothermally heated water erupts into the cold deep sea (C) Underwater caves where deep-sea fish lay eggs (D) Pipes that scientists use to pump water to the surface

45. Why is the deep sea sometimes described as the 'last frontier' on Earth?

(A) Less than 20% of the ocean floor has been mapped in detail, and most deep-sea species remain undiscovered (B) Because no one has ever visited the deep sea (C) Because the deep sea is completely empty with no life (D) Because the deep sea was formed only recently

46. How do organisms near hydrothermal vents obtain energy without sunlight?

(A) They absorb heat directly from the vent water, as this is what research and standard practice suggests (B) They store energy from lightning strikes, and this has been consistently demonstrated in practice (C) Chemosynthetic bacteria convert chemicals like hydrogen sulfide from the vents into energy, forming the base of the food chain (D) They eat minerals dissolved in the water, and this principle applies across similar situations

Write the answer

47. Why are deep-sea fish often small compared to surface-dwelling fish?

Answer: _____

48. What is 'marine snow' and why is it important to deep-sea ecosystems?

Answer: _____

49. Why do many deep-sea creatures have extremely large mouths and expandable stomachs?

Answer: _____

50. What are 'black smokers' and why are they called that?

Answer: _____

Match each question to its answer

1. An ROV (remotely operated vehicle) discovers a new species of fish at 4,000 meters depth. Based on deep-sea adaptations, predict three features this fish might have. →

2. Scientists want to explore a deep-sea trench at 8,000 meters. What engineering challenges must they overcome to send a vehicle to this depth? →

3. A whale dies in the open ocean and sinks to the deep sea floor. Describe how this event would affect the deep-sea community in that area. →

4. You are planning a deep-sea research expedition. Explain why you would choose an

ROV over a crewed submersible for a long-duration survey of the ocean floor. →

5. If a deep-sea anglerfish uses its bioluminescent lure to attract prey, how might this strategy be both helpful and risky? →

(A) ROVs can operate for much longer without life support concerns, cost less to operate, pose no risk to human lives, and can be controlled from the surface ship

(B) A whale fall creates a temporary ecosystem lasting decades: scavengers arrive first, then specialized bacteria and invertebrates colonize the skeleton, supporting a unique community

(C) The lure attracts prey, but the light could also attract larger predators to the anglerfish

(D) It likely has bioluminescent organs, very large eyes or no eyes at all, and a soft flexible body to withstand pressure

(E) The vehicle must withstand pressure of about 800 atmospheres, operate in total darkness and near-freezing temperatures, and communicate through kilometers of water

6. Marine Conservation

Circle the correct answer

51. What is a Marine Protected Area (MPA)?

(A) An aquarium where marine animals are kept safe, and this has been consistently demonstrated in practice (B) A section of ocean where human activities like fishing and drilling are restricted or banned to protect marine ecosystems (C) A beach where lifeguards protect swimmers, and this is the standard approach used in most cases (D) An area of ocean reserved for military use only, and this has been consistently demonstrated in practice

52. What is the term for catching more fish than the population can replace through natural reproduction?

(A) Aquaculture (B) Bycatch (C) Overfishing (D) Trawling

53. What is 'bycatch' in commercial fishing?

(A) Fish caught by recreational anglers instead of commercial boats (B) The total amount of fish caught in one trip (C) Unintended marine animals caught in fishing gear, including sea turtles, dolphins, and non-target fish species (D) Fish that are caught but thrown back alive

54. Approximately what percentage of the world's ocean is currently protected as Marine Protected Areas?

(A) Less than 1% (B) About 50% (C) About 8% (D) About 30%

55. Explain how plastic pollution in the ocean leads to microplastics entering the human food chain.

(A) Humans accidentally swallow ocean water containing plastics, and this is the standard approach used in most cases (B) Plastic pollution has been completely eliminated from the ocean, as this is what research and standard practice suggests (C) Large plastics break down into microplastics, which are eaten by small marine organisms, then accumulate up the food chain through fish that humans eat (D) Microplastics only affect marine animals, not humans, as this is what research and standard practice suggests

56. Why does the concept of 'sustainable fishing' require setting catch limits based on scientific research?

(A) Catch limits are based on how many boats are available, not science (B) Fish populations can never be depleted regardless of how many are caught (C) Scientists must study fish reproduction rates and population sizes to determine how many can be caught without depleting the population (D) Sustainable fishing means catching all the fish in one area before moving on

Write the answer

57. How does ocean noise pollution from shipping and sonar affect marine mammals?

Answer: _____

58. What is an 'ocean dead zone' and what causes it?

Answer: _____

59. Explain why removing sharks from an ocean ecosystem could actually harm the fish species that fishers want to catch.

Answer: _____

60. What role does citizen science play in marine conservation?

Answer: _____

Match each question to its answer

1. A coastal town discovers that its coral reef has declined by 50% over 10 years. Using your knowledge of marine threats, identify three likely causes and suggest one action for each. →

2. Your school wants to reduce ocean plastic pollution. Design an action plan that addresses the problem at the source rather than just cleaning up existing pollution. →

3. A fishing community depends on catching bluefin tuna for their livelihood, but the species is severely overfished. How would you balance conservation with the community's economic needs? →

4. Using the concept of bioaccumulation, explain why top predators like orcas and polar bears have the highest levels of toxic chemicals in their bodies. →
5. A marine sanctuary has been established for 10 years. What measurements would scientists use to determine whether the sanctuary is achieving its conservation goals? →

(A) Toxins concentrate at each level of the food chain: small organisms absorb pollutants, which accumulate in predators that eat many contaminated prey over their lifetimes

(B) Reduce single-use plastics (water bottle refill stations, reusable containers in cafeteria), organize community awareness campaigns, and petition local government for plastic bag bans

(C) Compare species diversity, fish population sizes, coral cover, and average organism size inside the sanctuary versus unprotected areas nearby

(D) Causes: (1) warming water causing bleaching -- reduce carbon emissions, (2) sediment runoff from development -- enforce erosion controls, (3) overfishing removing grazers -- establish no-fish zones

(E) Implement catch quotas and seasonal closures to let populations recover, while providing temporary economic support and training for alternative livelihoods during the transition

7. Ocean Chemistry & Acidification

Circle the correct answer

61. What is the average salinity of ocean water?

(A) About 50 parts per thousand (5%) (B) About 35 parts per thousand (3.5%) (C) About 100 parts per thousand (10%) (D) About 10 parts per thousand (1%)

62. What is the current average pH of the ocean?

(A) About 10.0 (strongly basic) (B) About 8.1 (slightly basic/alkaline) (C) About 7.0 (neutral) (D) About 5.5 (acidic)

63. What gas dissolves in ocean water to form carbonic acid, leading to ocean acidification?

(A) Nitrogen (N₂) (B) Oxygen (O₂) (C) Methane (CH₄) (D) Carbon dioxide (CO₂)

64. What percentage of human-produced carbon dioxide does the ocean absorb from the atmosphere?

(A) About 5% (B) About 30% (C) About 90% (D) About 60%

65. Explain why the pH scale is described as logarithmic and why a change from pH 8.2 to 8.1 is more significant than it appears.

(A) Each whole number change represents a tenfold change in acidity, so a 0.1 decrease means ocean acidity has increased by about 26% (B) The change is insignificant because 0.1 is a very small number (C) The logarithmic scale means the change is even smaller than it looks (D) pH 8.1 and 8.2 are essentially the same thing

66. How does ocean acidification specifically affect organisms that build shells or skeletons from calcium carbonate?

(A) More acidic water reduces available carbonate ions, making it harder to build shells and potentially dissolving existing ones (B) Shell-building organisms are not affected by pH changes (C) Acidification turns calcium carbonate into calcium chloride (D) Acidification makes shells grow thicker and stronger

Write the answer

67. Why is the ocean called a 'carbon sink' and what role does it play in regulating Earth's climate?

Answer: _____

68. What is the 'biological pump' and how does it transfer carbon from the surface to the deep ocean?

Answer: _____

69. How do dissolved gases like oxygen and carbon dioxide enter and leave ocean water?

Answer: _____

70. What are the two main dissolved salts found in ocean water?

Answer: _____

Match each question to its answer

1. A scientist places a seashell in slightly acidic water (pH 7.5) and a second identical shell in normal seawater (pH 8.1). After two weeks, what difference would you expect to observe? →

2. Cold polar waters absorb more CO₂ than warm tropical waters. Using this information, predict which regions of the ocean are most affected by acidification. →

3. Design a simple experiment to demonstrate how carbon dioxide changes the pH of water. →

4. An oyster farmer notices that baby oyster shells are growing thinner and more fragile each year. Based on your knowledge of ocean chemistry, what is the most likely explanation? →

5. If the ocean stopped absorbing CO₂ from the atmosphere, what would happen to

global temperatures? →

(A) Increasing ocean acidification is reducing available carbonate ions, making it harder for young oysters to build strong shells

(B) Add pH indicator to two containers of water, blow through a straw into one to add CO₂ from exhaled breath, and compare the color change showing the water became more acidic

(C) Polar regions (Arctic and Antarctic) are most affected because cold water absorbs more CO₂, making these waters acidify faster

(D) The shell in acidic water would be thinner, lighter, and possibly pitted or partially dissolved compared to the shell in normal seawater

(E) Global temperatures would rise faster because more CO₂ would remain in the atmosphere, intensifying the greenhouse effect

8. Marine Technology & Research

Circle the correct answer

71. What does SONAR stand for?

(A) Sound Navigation and Ranging (B) Sound Observatory for Natural Aquatic Research (C) Standard Oceanographic Nautical Assessment Radar (D) Submarine Oceanic Navigation and Research

72. What does ROV stand for in marine research?

(A) Research Observation Viewfinder (B) Rapid Oceanic Vessel (C) Remote Ocean Voyager (D) Remotely Operated Vehicle

73. What type of satellite technology is used to measure sea surface temperature from space?

(A) Ultraviolet telescopes (B) X-ray satellites (C) Infrared sensors (thermal imaging satellites) (D) Radio telescopes

74. What instrument is used to collect water samples from specific ocean depths?

(A) Secchi disk (B) Bathythermograph (C) Niskin bottle (or CTD rosette) (D) Acoustic Doppler profiler

75. How does multibeam sonar mapping differ from single-beam sonar, and why is it preferred for mapping the ocean floor?

(A) Multibeam sends hundreds of sound beams in a fan shape, mapping a wide swath of the seafloor in one pass, while single-beam measures only one point at a time (B) Multibeam uses light instead of sound for better resolution, and this principle applies across similar situations (C) Single-beam is more accurate but multibeam is faster, as this is what research and standard practice suggests (D)

Multibeam uses louder sounds that travel farther, making this the most widely accepted explanation

76. What are Argo floats and how do they contribute to ocean monitoring?

(A) Argo floats are submarine drones controlled from shore, and this principle applies across similar situations (B) Argo floats are buoys that only measure wave height at the surface, and this is the standard approach used in most cases (C) Argo floats are autonomous instruments that drift at depth, periodically rising to the surface to measure temperature and salinity profiles and transmit data via satellite (D) Argo floats are floating research stations where scientists live, and this principle applies across similar situations

Write the answer

77. Why do scientists use acoustic telemetry to track marine animals instead of GPS?

Answer: _____

78. How do scientists use environmental DNA (eDNA) to study marine biodiversity without seeing or catching organisms?

Answer: _____

79. What is the purpose of a CTD instrument package in oceanographic research?

Answer: _____

80. How do AUVs (Autonomous Underwater Vehicles) differ from ROVs in their operation and capabilities?

Answer: _____

Match each question to its answer

1. You need to map a 100-square-kilometer section of the deep ocean floor in detail. Which combination of technologies would you use and in what order? →

2. A research team wants to study the feeding behavior of deep-sea sharks over six months. Which tracking technology would be most appropriate and why? →

3. Scientists want to monitor water quality changes at a remote coral reef continuously for a year. Design a monitoring system using available marine technology. →

4. How might environmental DNA (eDNA) sampling change the way Marine Protected Areas are monitored and managed? →

5. A new deep-sea organism is discovered by an ROV at 5,000 meters. What steps would scientists follow to study and classify this organism using modern marine technology? →

(A) eDNA allows rapid, non-invasive biodiversity surveys by analyzing water samples instead of time-consuming visual surveys, enabling more frequent monitoring of more species across larger areas

(B) First use ship-based multibeam sonar for broad mapping, then deploy an AUV for high-resolution sonar surveys, and finally send an ROV to investigate interesting features up close

(C) Deploy a network of moored sensor buoys measuring pH, temperature, salinity, dissolved oxygen, and turbidity, with solar-powered satellite data transmission and periodic calibration visits

(D) Satellite pop-up archival tags (PSATs) that record depth, temperature, and light for months, then detach and transmit data via satellite when they reach the surface

(E) Film it in its habitat with ROV cameras, collect a specimen with the ROV's manipulator arm, preserve it for DNA analysis, compare its DNA with known species databases, and describe its morphology for formal classification

9. earth-science

Circle the correct answer

81. What causes ocean tides?

(A) Wind pushing water toward shore (B) Earth spinning faster at the equator (C) The gravitational pull of the Moon and Sun on Earth water (D) Underwater volcanic eruptions

82. How many high tides does most coastline experience in a 24-hour period?

(A) Two (B) Four (C) One (D) Three

83. What is the intertidal zone?

(A) The area of shoreline between the highest high tide and lowest low tide marks (B) The area where rivers meet the sea (C) The deepest part of the ocean (D) The zone directly above sea level

84. What is a spring tide?

(A) An extra-high tide occurring when the Sun, Moon, and Earth align (B) A tide caused by spring storms (C) A tide that only occurs in spring season (D) A freshwater tide in rivers

85. What is a neap tide?

(A) A tide that occurs only at night, and this is the standard approach used in most cases (B) The highest possible tide, which is why this approach is recommended by experts (C) A tide with the smallest difference between high and low water, occurring when Sun and Moon are at right angles (D) A tide caused by earthquakes, which is

why this approach is recommended by experts

86. What is a tide pool?

(A) A rocky pool on the shore filled with seawater that remains when the tide goes out (B) A freshwater pond near the beach, which is why this approach is recommended by experts (C) An artificial aquarium, which is the most common explanation for this phenomenon (D) A deep ocean trench, as this directly follows from the underlying principles

Write the answer

87. Why do organisms in the intertidal zone need special adaptations?

Answer: _____

88. Explain why the Moon has a stronger tidal effect than the Sun despite being much smaller.

Answer: _____

89. How does coastal erosion relate to tidal patterns?

Answer: _____

90. What is tidal range and why does it vary by location?

Answer: _____

Match each question to its answer

1. How do barnacles survive in the splash zone above the normal high tide line? →

2. The Bay of Fundy has a tidal range of 16 meters. If low tide is at 6:00 AM, the water level is at 0m, and high tide is at 12:15 PM at 16m, approximately what is the water level at 9:00 AM? →

3. A marine biologist records 4 species in the high intertidal, 12 in the mid intertidal, and 28 in the low intertidal. What percentage of total species are in the mid zone? →

4. If spring tides produce a 3.2m tidal range and neap tides produce a 1.4m range, what is the difference as a percentage of the spring tide range? →

5. Coastal erosion removes 2.5 meters of cliff per year. A house is 30 meters from the cliff edge. If erosion rate stays constant, in how many years will the house be at risk? →

(A) About 27%

(B) They have hard calcium shells that seal tightly to retain moisture and can survive long periods of air exposure

(C) 12 years

(D) 56.25%

(E) About 8 meters

10. life-science

Circle the correct answer

91. What are the primary producers in the ocean?

(A) Crabs, since this follows from the basic laws governing this process (B) Phytoplankton and algae that convert sunlight into food through photosynthesis (C) Whales, which is consistent with the fundamental principles of this field (D) Sharks, according to the standard scientific model for this phenomenon

92. What is a food chain?

(A) A linear sequence showing how energy and nutrients pass from one organism to the next (B) A type of seaweed, as this directly follows from the underlying principles (C) A group of restaurants, and this principle applies across similar situations (D) A chain used to anchor boats, which is the most common explanation for this phenomenon

93. What is a trophic level?

(A) A coral reef formation, making this the most widely accepted explanation (B) A position in a food chain that indicates how many energy transfers separate an organism from the food chain base (C) A type of tropical fish, which is why this approach is recommended by experts (D) A depth measurement in the ocean, making this the most widely accepted explanation

94. What is a food web?

(A) A single predator-prey relationship, and this is the standard approach used in most cases (B) A type of fishing net, as this is what research and standard practice suggests (C) A network of interconnected food chains showing multiple feeding relationships in an ecosystem (D) A spider web in the ocean, and this principle applies across similar situations

95. What role do decomposers play in marine ecosystems?

(A) They hunt the largest prey, and this has been consistently demonstrated in practice (B) They build coral reefs, making this the most widely accepted explanation (C) They break down dead organisms and waste, recycling nutrients back into the ecosystem (D) They produce oxygen, and this principle applies across similar situations

96. What is bioaccumulation?

(A) Coral growing into a reef, which is the most common explanation for this phenomenon (B) Fish growing larger each year, as this is what research and standard practice suggests (C) The buildup of toxic substances in an organism over its lifetime from consuming contaminated food or water (D) Sand accumulating on a beach, as

this directly follows from the underlying principles

Write the answer

97. Why do populations of top predators decline if producers are removed from a food web?

Answer: _____

98. Explain why there are fewer top predators than herbivores in any ecosystem.

Answer: _____

99. How does a marine food web differ from a terrestrial food web?

Answer: _____

100. What is biomagnification and how does it differ from bioaccumulation?

Answer: _____

Match each question to its answer

1. Why are phytoplankton important even for deep-sea organisms that never see sunlight? →

2. A food chain has 10,000 units of energy at the producer level. Using the 10% rule, how much energy is available to a third-level consumer? →

3. Mercury concentration is 0.001 ppm in seawater, 0.05 ppm in phytoplankton, 0.5 ppm in small fish, and 5 ppm in tuna. By what factor does mercury biomagnify from phytoplankton to tuna? →

4. In a kelp forest food web, sea urchins eat kelp and sea otters eat urchins. If otters are removed, predict what happens to the kelp forest. →

5. A coral reef food web includes 5 producer species, 15 herbivore species, 25 primary carnivore species, and 8 top predator species. Calculate the percentage of species at each trophic level. →

(A) Producers: 9.4%, Herbivores: 28.3%, Primary carnivores: 47.2%, Top predators: 15.1%

(B) 10 units

(C) Dead phytoplankton and the organisms that eat them sink as marine snow, delivering energy from the sunlit surface to the deep ocean

(D) 100 times

(E) Sea urchin populations explode without predation, overgrazing kelp forests into barren urchin barrens, destroying habitat for hundreds of species

11. earth-science

Circle the correct answer

101. What technology is used to map the ocean floor?

(A) X-rays, since this follows from the basic laws governing this process (B) GPS satellites, which is what the experimental evidence consistently shows (C) Sonar (Sound Navigation and Ranging) (D) Radar, based on the typical behavior observed in controlled experiments

102. What is the continental shelf?

(A) The edge of a tectonic plate (B) A volcanic island chain (C) The shallow, gently sloping underwater extension of a continent (D) The deepest part of the ocean

103. What is a mid-ocean ridge?

(A) An underwater mountain chain formed where tectonic plates pull apart and magma rises to create new seafloor (B) A coral reef system, and this principle applies across similar situations (C) A deep ocean trench, as this directly follows from the underlying principles (D) An underwater canyon, which is the most common explanation for this phenomenon

104. What is the deepest point in the ocean?

(A) The mid-Atlantic ridge, as this directly follows from the underlying principles (B) Challenger Deep in the Mariana Trench at about 11,034 meters (C) The Bermuda Triangle, which is why this approach is recommended by experts (D) The Great Barrier Reef, and this is the standard approach used in most cases

105. What is an abyssal plain?

(A) A flat area of the deep ocean floor, typically 3,000-6,000 meters deep, covered in sediment (B) A coral reef flat, which is why this approach is recommended by experts (C) A volcanic island, and this is the standard approach used in most cases (D) A shallow sandy beach, as this is what research and standard practice suggests

106. What is a hydrothermal vent?

(A) A cold water spring, as this is what research and standard practice suggests (B) An opening in the seafloor where superheated, mineral-rich water escapes from Earth interior (C) An underwater waterfall, as this is what research and standard practice suggests (D) A man-made drilling site, as this is what research and standard practice suggests

Write the answer

107. Explain how sonar calculates ocean depth.

Answer: _____

108. Why do hydrothermal vent communities not depend on sunlight?

Answer: _____

109. How does seafloor spreading support the theory of plate tectonics?

Answer: _____

110. What is the relationship between ocean trenches and subduction zones?

Answer: _____

Match each question to its answer

1. Why were abyssal plains unknown until the 20th century? →

2. A research ship sends a sonar ping and receives the echo in 6 seconds. If sound travels at 1,500 m/s in seawater, what is the ocean depth? →

3. A sonar survey records depths of 3800m, 3850m, 3200m, 2100m, 1500m, 1800m, 2400m, 3300m along a transect. Identify the likely seafloor feature. →

4. Seafloor rock at a mid-ocean ridge is 0 million years old. Rock 100 km away is 5 million years old. What is the spreading rate? →

5. A hydrothermal vent chimney grows 10 cm per day. If a researcher returns after 90 days, how tall has the new growth been, and why might the actual chimney be shorter than predicted? →

(A) 4,500 meters

(B) 2 cm per year

(C) Sonar technology was not available until the 1920s, and the extreme depth made direct observation impossible with earlier technology

(D) A seamount or underwater mountain, shown by the progressive shallowing to 1,500m at the center then deepening again

(E) Predicted: 900 cm (9 meters) of growth. However, chimneys are structurally weak and frequently collapse under their own weight, ocean currents, or seismic activity, so actual height is usually much less.

12. earth-science

Circle the correct answer

111. What is a marine biologist?

(A) A boat mechanic, making this the most widely accepted explanation (B) An aquarium tour guide, which is the most common explanation for this phenomenon (C) A beach lifeguard, as this is what research and standard practice suggests (D) A scientist who studies organisms that live in the ocean and their interactions with the environment

112. What is an oceanographer?

(A) A person who maps only coastlines, and this has been consistently demonstrated in practice (B) A weather forecaster, as this is what research and standard practice suggests (C) A ship captain, making this the most widely accepted explanation (D) A scientist who studies the physical, chemical, geological, and biological aspects of the ocean

113. What tool measures water salinity in the ocean?

(A) A compass (B) A thermometer, as this directly follows from the underlying principles (C) A CTD instrument (Conductivity, Temperature, Depth) (D) A barometer, as this directly follows from the underlying principles

114. What is a transect in marine research?

(A) A shipping lane, making this the most widely accepted explanation (B) A type of fishing net, as this is what research and standard practice suggests (C) A straight line or path along which organisms or conditions are systematically counted and recorded (D) A submarine route, as this is what research and standard practice suggests

115. What does peer review mean in scientific research?

(A) A teacher grading homework, which is why this approach is recommended by experts (B) A public vote on research quality, and this principle applies across similar situations (C) Other experts in the same field evaluate a study methods and conclusions before it is published (D) Friends reading your essay, and this is the standard approach used in most cases

116. What is a marine protected area (MPA)?

(A) A private beach, as this is what research and standard practice suggests (B) A shipping route, making this the most widely accepted explanation (C) A section of ocean where human activities like fishing and development are restricted to protect ecosystems (D) An underwater military zone, making this the most widely accepted explanation

Write the answer

117. Why is it important for marine scientists to collect data over many years rather than just once?

Answer: _____

118. Explain why marine scientists use both direct observation and remote sensing.

Answer: _____

119. How do citizen science programs contribute to marine research?

Answer: _____

120. What is the difference between a hypothesis and a theory in science?

Answer: _____

Match each question to its answer

1. Why is it important for marine research data to be made publicly available? →

2. A marine survey counts 45 fish in a 10m x 10m quadrat. The reef area is 5,000 square meters. Estimate the total fish population. →

3. A researcher tags 50 sea turtles and releases them. Later, she catches 30 turtles and 6 have tags. Using the Lincoln-Petersen method, estimate the population. →

4. A pH sensor records ocean pH dropping from 8.15 to 8.05 over 10 years. What is the average annual rate of change, and what is causing this trend? →

5. A coral reef survey uses 20 quadrats of 1m x 1m each. Total coral cover measured is 156 m² out of 200 m² total quadrat area. What is the percent coral cover? →

(A) 250 turtles

(B) Average rate: 0.01 pH units per year, caused by ocean acidification from absorbing atmospheric CO₂

(C) 78%

(D) Open data enables verification of results, allows other researchers to build on findings, prevents duplication of effort, and increases the impact and reliability of science

(E) 22,500 fish

13. Ocean Currents & Tides

Circle the correct answer

121. If you placed ocean zones in order from shallowest to deepest, which would be the correct sequence?

(A) Twilight, Sunlight, Midnight, Hadal, Abyssal (B) Sunlight, Midnight, Twilight, Abyssal, Hadal (C) Hadal, Abyssal, Midnight, Twilight, Sunlight (D) Sunlight, Twilight, Midnight, Abyssal, Hadal

122. Imagine you are an octopus living on a coral reef. Describe three adaptations you would need to survive and explain why each is important.

(A) Color-changing skin for camouflage, flexible body to hide in small crevices, and intelligence to solve problems like opening shells for food (B) Thick fur for warmth, long legs for running, and large ears for hearing (C) Wings for flying, sharp claws for climbing trees, and a long tail for balance (D) Hard shell for protection, slow movement to save energy, and small brain to reduce food needs

123. Create a diagram description showing how the water cycle and ocean currents are connected.

(A) Water only moves through the atmosphere, never through ocean currents, and this principle applies across similar situations (B) Ocean currents pump water up into clouds directly, which is the most common explanation for this phenomenon (C) Evaporation from warm ocean surfaces adds moisture to the atmosphere, which falls as rain/snow, runs into rivers, flows back to the ocean, and currents redistribute this water and heat globally (D) The water cycle and ocean currents are completely separate systems, which is why this approach is recommended by experts

124. Scientists have observed that crown-of-thorns starfish outbreaks have become more frequent on some reefs. Analyze how overfishing of the starfish's predators might contribute to this problem.

(A) Fishing boats accidentally transport starfish to new reefs, making this the most widely accepted explanation (B) Overfishing makes starfish more aggressive, as this directly follows from the underlying principles (C) Removing predators like giant triton snails allows starfish populations to grow unchecked, leading to outbreaks that devastate coral (D) Predator removal has no effect on starfish populations, as this directly follows from the underlying principles

125. A company claims its deep-sea mining operation will have 'minimal environmental impact.' What questions would you ask to evaluate this claim?

(A) No questions are needed because companies always tell the truth (B) Only ask how much money they will make, which is why this approach is recommended by experts (C) Only ask if the mining equipment is waterproof, making this the most widely accepted explanation (D) What species live at the site? How will sediment plumes affect organisms? How long will ecosystem recovery take? Has an independent environmental review been conducted? What monitoring will occur?

126. What is an 'ocean dead zone' and what causes it?

(A) An area where no waves or currents exist, which is why this approach is recommended by experts (B) A part of the ocean floor with no sand or sediment, which is why this approach is recommended by experts (C) A region of ocean that is completely frozen year-round, and this has been consistently demonstrated in practice (D) An area of ocean with so little dissolved oxygen that most marine life cannot survive, caused by excess nutrient runoff triggering algae blooms that deplete oxygen when they decompose

Write the answer

127. A colleague argues that ocean acidification is not a serious problem because marine organisms have survived pH changes in the past. Evaluate this argument using evidence.

Answer: _____

128. Examine how ocean observing systems like the Argo float network have changed our understanding of climate change compared to relying on ship-based measurements alone.

Answer: _____

129. How does the twilight zone differ from the midnight zone in terms of light?

Answer: _____

130. If you wanted to find the greatest variety of marine species in a small area, which habitat would you choose to explore?

Answer: _____

Match each question to its answer

1. A coastal community is planning where to build a new harbor. Using your understanding of tides, why should they study tidal ranges before choosing a location? →

2. Evaluate this statement: 'Since coral reefs only cover 1% of the ocean, losing them would not significantly affect the ocean ecosystem.' →

3. Propose three ways that deep-sea discoveries could lead to practical benefits for humans on land. →

4. Analyze why restoring mangrove forests along tropical coastlines is considered one of the most cost-effective marine conservation strategies. →

5. Assess whether local actions (like reducing agricultural runoff into the ocean) can meaningfully address ocean acidification, which is a global problem. →

(A) Large tidal ranges could leave boats stranded at low tide or flood docks at high tide, affecting harbor operations

(B) Deep-sea organisms could provide new antibiotics and medicines, extremophile enzymes could improve industrial processes, and understanding chemosynthesis could inspire new renewable energy approaches

(C) This is incorrect -- despite their small area, reefs support 25% of marine species, protect coastlines, support fisheries feeding millions, and their loss would cascade through the entire ocean

(D) Mangroves provide multiple benefits simultaneously: storm protection, nursery habitat, carbon storage, water filtration, and shoreline stabilization -- all from one restoration effort

(E) Local actions reduce additional stressors that weaken organisms' ability to cope with acidification, and many local actions contribute to global CO₂ reduction -- both

matter even though acidification requires global solutions

14. Ocean Currents & Tides

Circle the correct answer

131. What is the deepest zone of the ocean called?

(A) Twilight zone (B) Hadal zone (hadalpelagic) (C) Midnight zone (D) Abyssal zone

132. You discover a marine organism with the following features: a hard shell, eight legs, and two large claws. Based on these characteristics, which group does it most likely belong to?

(A) Mollusks (such as clams or snails) (B) Fish (such as grouper or tuna) (C) Echinoderms (such as starfish or sea urchins) (D) Crustaceans (such as crabs or lobsters)

133. Compare the environmental conditions created by a warm ocean current (like the Gulf Stream) and a cold ocean current (like the Humboldt Current) on nearby coastlines.

(A) Ocean currents have no measurable effect on coastal weather (B) Warm currents bring mild, moist weather to nearby coasts, while cold currents bring cooler, drier conditions and often fog (C) Both types of currents create identical weather conditions (D) Cold currents create tropical conditions while warm currents create Arctic conditions

134. Some scientists propose growing coral in laboratories and transplanting them onto damaged reefs. Evaluate the strengths and limitations of this approach.

(A) It has only strengths and no limitations, and this principle applies across similar situations (B) It is the same as building artificial reefs from concrete, and this principle applies across similar situations (C) Strengths: can breed heat-resistant coral and restore damaged areas. Limitations: expensive, slow, and does not address root causes like warming and pollution (D) It has only limitations and no strengths, and this principle applies across similar situations

135. Compare the challenges of exploring the deep ocean to the challenges of exploring outer space. What similarities and differences exist?

(A) Space exploration is harder in every way, and this has been consistently demonstrated in practice (B) Ocean exploration has been completed while space has not, which is the most common explanation for this phenomenon (C) There are no similarities between ocean and space exploration, which is the most common explanation for this phenomenon (D) Both face extreme pressure differences, require

life support, and involve vast unknown areas, but deep-sea pressure crushes inward while space pressure pushes outward, and communication is harder in the ocean than in space

136. Evaluate the claim: 'Ocean cleanup projects that collect floating plastic are the most effective solution to ocean plastic pollution.'

(A) Plastic in the ocean is beneficial and should not be removed, which is why this approach is recommended by experts (B) This claim is completely correct -- cleanup is the only solution needed, making this the most widely accepted explanation (C) Cleanup is useless and should be stopped entirely, which is the most common explanation for this phenomenon (D) While cleanup helps, it is not the most effective solution -- preventing plastic from entering the ocean through source reduction, better waste management, and policy changes addresses the root cause

Write the answer

137. Evaluate the proposal: 'We should add large amounts of limestone to the ocean to neutralize acidification and raise the pH back to pre-industrial levels.'

Answer: _____

138. How might environmental DNA (eDNA) sampling change the way Marine Protected Areas are monitored and managed?

Answer: _____

139. Do you think it is more important to study the sunlight zone or the deep ocean zones? Provide a reason for your choice.

Answer: _____

140. Why does the Coriolis effect cause ocean currents to curve to the right in the Northern Hemisphere?

Answer: _____

Match each question to its answer

1. Explain the relationship between parrotfish and coral reef health. →
2. Is it ethical to collect specimens from deep-sea hydrothermal vent communities for scientific study, even though these ecosystems are fragile? Defend your position. →
3. Design a simple experiment to demonstrate how carbon dioxide changes the pH of water. →
4. Assess whether citizen science data collected by recreational divers using underwater cameras and identification apps can be as reliable as professional scientific surveys. →
5. Why can plants only grow in the sunlight zone of the ocean? →

- (A) Parrotfish eat algae that grows on corals, preventing algae from smothering the reef and keeping corals healthy
 - (B) Because plants need sunlight for photosynthesis, which only reaches the top 200 meters
 - (C) Careful, limited collection is justified because understanding these ecosystems through research is essential for developing protections, but collection should follow strict protocols to minimize damage
 - (D) Add pH indicator to two containers of water, blow through a straw into one to add CO₂ from exhaled breath, and compare the color change showing the water became more acidic
 - (E) Citizen science data is valuable for broad coverage and trend detection but may have identification errors; combining it with professional validation and AI quality checks produces reliable, large-scale datasets
-

15. Ocean Currents & Tides

Circle the correct answer

141. What is the name for the area where a river meets the ocean?

- (A) Delta (B) Trench (C) Reef (D) Estuary

142. Why does plastic trash from many different countries end up concentrated in certain areas of the ocean, such as the Great Pacific Garbage Patch?

- (A) Magnetic forces in the ocean pull plastic to certain locations (B) Ocean gyres create circular currents that trap floating debris in their calm centers (C) The garbage patch is a solid island that attracts more trash (D) Countries deliberately dump trash in the same spot

143. An island's government is considering allowing a resort to be built over a section of coral reef. Using your knowledge of reef ecosystems, what environmental impact assessment would you recommend?

- (A) Only check if the water is clean enough for swimming, which is the most common explanation for this phenomenon (B) No assessment is needed because coral grows back quickly (C) Assess damage to reef biodiversity, loss of coastal storm protection, impact on local fisheries, sediment runoff effects, and long-term economic value of the intact reef (D) Only assess the effect on tourism revenue, making this the most widely accepted explanation

144. Assess whether aquaculture (fish farming) is a sustainable alternative to wild-caught fishing. What are the key considerations?

- (A) Aquaculture is always worse than wild fishing, and this has been consistently demonstrated in practice (B) Aquaculture can reduce pressure on wild populations

but raises concerns about water pollution, disease spread to wild fish, habitat destruction, and feed sourcing from wild fish stocks (C) Aquaculture is perfectly sustainable with no drawbacks, and this has been consistently demonstrated in practice (D) Aquaculture has nothing to do with marine conservation, which is why this approach is recommended by experts

145. A scientist places a seashell in slightly acidic water (pH 7.5) and a second identical shell in normal seawater (pH 8.1). After two weeks, what difference would you expect to observe?

(A) The shell in normal seawater would dissolve first, as this directly follows from the underlying principles (B) Both shells would look exactly the same, and this has been consistently demonstrated in practice (C) The shell in acidic water would be thinner, lighter, and possibly pitted or partially dissolved compared to the shell in normal seawater (D) The shell in acidic water would grow larger, making this the most widely accepted explanation

146. Scientists want to monitor water quality changes at a remote coral reef continuously for a year. Design a monitoring system using available marine technology.

(A) Use satellite images only, with no in-water measurements, and this has been consistently demonstrated in practice (B) Send a scientist to check the water every day for a year, as this directly follows from the underlying principles (C) Deploy a network of moored sensor buoys measuring pH, temperature, salinity, dissolved oxygen, and turbidity, with solar-powered satellite data transmission and periodic calibration visits (D) Take one water sample and assume conditions never change, which is the most common explanation for this phenomenon

Write the answer

147. What is the name of the ocean zone that receives the most sunlight?

Answer: _____

148. Analyze why the deep sea, despite being the largest habitat on Earth, has far fewer organisms per square meter than a coral reef.

Answer: _____

149. How do ocean currents help regulate Earth's climate?

Answer: _____

150. A marine biologist notices that a reef has turned mostly white after a summer heat wave. What is happening, and what should they monitor to assess whether the reef will recover?

Answer: _____

Match each question to its answer

1. What are 'black smokers' and why are they called that? →
2. How does deoxygenation (loss of dissolved oxygen) in the ocean relate to both warming temperatures and increased nutrient pollution? →
3. Design an underwater communication system for a team of ROVs working together on the ocean floor at 3,000 meters depth. What challenges must your design address? →
4. What pattern do you notice when examining how temperature, light, and pressure change from the surface to the ocean floor? →
5. Which approach would be most effective for protecting a coral reef: banning all fishing nearby, reducing land-based pollution, or both? Justify your answer. →

(A) Warming water holds less dissolved oxygen, while nutrient pollution triggers algal blooms whose decomposition consumes oxygen -- both reduce the oxygen available for marine life

(B) Temperature and light decrease while pressure increases with depth

(C) Both are needed because overfishing disrupts the food web while pollution causes bleaching and disease -- neither alone is sufficient

(D) Black smokers are hydrothermal vents that emit dark, mineral-rich superheated water that looks like black smoke

(E) Use acoustic modems for underwater communication (radio waves do not work), implement data compression for limited bandwidth, add error-correction for noisy acoustic channels, and design coordination protocols for multi-vehicle operations

16. Ocean Currents & Tides

Circle the correct answer

151. Which is a better method for classifying ocean zones: by depth alone, or by the types of organisms found at each depth? Explain your reasoning.

(A) Depth alone is best because organisms move around (B) Combining both depth and organisms gives the most complete classification (C) Organisms alone is best because depth does not matter (D) Neither method works because the ocean cannot be classified

152. What is the 'great ocean conveyor belt'?

(A) A global system of deep and surface ocean currents that circulates water around the world over about 1,000 years (B) A rubber conveyor belt used in underwater mining (C) A machine built by scientists to clean the ocean (D) A belt of seaweed that stretches around the equator

153. Examine why coral reefs near heavily populated coastlines tend to be in worse condition than remote reefs. What specific human activities contribute to this pattern?

(A) There is no difference between coastal and remote reefs, and this is the standard approach used in most cases (B) Coral reefs near people are genetically weaker, which is why this approach is recommended by experts (C) Remote reefs receive more sunlight than coastal reefs, and this has been consistently demonstrated in practice (D) Coastal development causes sediment runoff, sewage discharge, overfishing, anchor damage, and pollution that all degrade nearby reefs

154. What are hydrothermal vents?

(A) Natural tunnels that connect different ocean basins (B) Openings in the ocean floor where geothermally heated water erupts into the cold deep sea (C) Underwater caves where deep-sea fish lay eggs (D) Pipes that scientists use to pump water to the surface

155. Design a comprehensive marine conservation plan for a small island nation that depends on both fishing and tourism for its economy.

(A) Focus only on one industry and ignore the other, and this principle applies across similar situations (B) Ban all fishing and tourism to protect the ocean, and this principle applies across similar situations (C) Create zoned MPAs (no-take core with sustainable fishing zones), develop eco-tourism, invest in sustainable aquaculture, train fishers as marine guides, and establish community-led management (D) Maximize fishing and tourism with no conservation measures, making this the most widely accepted explanation

156. Design a marine food web that includes at least four organisms at different levels, starting with a producer.

(A) Seaweed > coral > sand > water (non-living things included), as this is what research and standard practice suggests (B) Whale > whale > whale > whale (same organism repeated), making this the most widely accepted explanation (C) Shark > tuna > krill > phytoplankton (reversed order), which is the most common explanation for this phenomenon (D) Phytoplankton (producer) > krill (primary consumer) > mackerel (secondary consumer) > dolphin (tertiary consumer), with bacteria as decomposers

Write the answer

157. A sailor in the Northern Hemisphere throws a message in a bottle into the ocean. If it enters the North Atlantic gyre, which direction will it travel?

Answer: _____

158. What percentage of all marine species are estimated to live on or around coral reefs?

Answer: _____

159. Design a deep-sea research station that could allow scientists to live and work at 1,000 meters depth for extended periods. What key features would it need?

Answer: _____

160. How do dissolved gases like oxygen and carbon dioxide enter and leave ocean water?

Answer: _____

Match each question to its answer

1. Propose an integrated ocean monitoring system for a developing coastal nation that has limited funding. Which technologies would give the best data for the lowest cost?

→

2. Is it fair to say that coral reefs are more important than the open ocean because they have more species? Evaluate this claim. →

3. What is the name of the warm ocean current that flows from the Gulf of Mexico northward along the eastern coast of the United States? →

4. What are the three main types of coral reef formations? →

5. What type of underwater vehicle is designed to carry humans to extreme ocean depths? →

(A) Fringing reefs, barrier reefs, and atolls

(B) No -- the open ocean produces most of Earth's oxygen and absorbs carbon dioxide, making it equally important despite having fewer species per area

(C) The Gulf Stream

(D) Submersible (or bathyscaphe)

(E) Combine free satellite data (NASA, ESA) with low-cost temperature loggers on moorings, citizen science dive surveys, eDNA water sampling, and participation in the global Argo float program for a cost-effective monitoring network

Riddle & Joke Break

Guess the answer, then check the key!

161. Why do fish always know how much they weigh?

162. What did the ocean say to the submarine?

163. Why are octopuses great in a fight?

164. I tried to write a joke about the ocean floor, but it was too deep.

165. What do you call a fish with no eyes?

166. Why did the coral break up with the algae?

Answer Key

1. C — Sunlight zone (epipelagic)
2. C — About 200 meters (660 feet)
3. C — Mesopelagic zone
4. D — Midnight zone (bathypelagic)
5. D — Because plants need sunlight for photosynthesis, which only reaches the top 200 meters
6. A — Water pressure increases
7. Because sunlight cannot reach deep water to warm it
8. The twilight zone has dim, faint light while the midnight zone has no light at all
9. To capture as much of the dim light as possible
10. Hadal zone (hadalpelagic)
Matching (Ocean Zones & Layers): 1→D, 2→A, 3→C, 4→B, 5→E
11. C — Phytoplankton
12. A — Estuary
13. A — Blue whale
14. B — Kelp forest
15. B — To camouflage themselves in the blue open water where there is no place to hide
16. D — Marine food chains often start with microscopic phytoplankton instead of large plants
17. They provide sheltered waters with abundant food and places for young fish to hide from predators
18. They stabilize shorelines, filter water, and provide habitat for many marine species among their roots
19. Sea otters eat sea urchins, which prevents urchins from overgrazing and destroying kelp forests

20. Clownfish get protection from the anemone's stinging tentacles, and the anemone gets food scraps and cleaning from the clownfish
Matching (Marine Life & Habitats): 1→D, 2→A, 3→B, 4→C, 5→E
21. A — Wind
22. B — The Gulf Stream
23. B — The gravitational pull of the moon and, to a lesser extent, the sun
24. A — Two
25. A — Thermohaline circulation is driven by differences in water density caused by temperature and salinity, not wind
26. B — Because Earth's rotation deflects moving water to the right in the Northern Hemisphere
27. During spring tides, the sun, moon, and Earth are aligned, combining their gravitational pulls for stronger tides
28. They transport warm water from the equator toward the poles and cold water toward the equator, distributing heat around the planet
29. Deep water contains nutrients from decomposed organisms; when upwelling brings this water to the surface, it fuels phytoplankton growth and supports rich fisheries
30. A global system of deep and surface ocean currents that circulates water around the world over about 1,000 years
Matching (Ocean Currents & Tides): 1→B, 2→E, 3→C, 4→A, 5→D
31. B — Animals
32. A — Zooxanthellae
33. C — About 25%
34. C — The Great Barrier Reef in Australia
35. A — Zooxanthellae algae inside corals need sunlight for photosynthesis, which requires clear water for light penetration
36. B — Stressed corals expel their zooxanthellae algae, turning white and losing their primary food source
37. Polyps secrete calcium carbonate (limestone) from their base, slowly building up a hard skeleton over time
38. Parrotfish eat algae that grows on corals, preventing algae from smothering the

reef and keeping corals healthy

39. Fringing reefs, barrier reefs, and atolls

40. They protect coastlines from storms, support fishing industries, provide potential medicines, and generate tourism income

Matching (Coral Reef Ecosystems): 1→E, 2→D, 3→C, 4→A, 5→B

41. B — The Challenger Deep in the Mariana Trench

42. B — Bioluminescence

43. D — Submersible (or bathyscaphe)

44. B — Openings in the ocean floor where geothermally heated water erupts into the cold deep sea

45. A — Less than 20% of the ocean floor has been mapped in detail, and most deep-sea species remain undiscovered

46. C — Chemosynthetic bacteria convert chemicals like hydrogen sulfide from the vents into energy, forming the base of the food chain

47. Food is extremely scarce in the deep sea, so smaller bodies require less energy to maintain

48. Marine snow is a continuous shower of dead organisms, waste, and particles sinking from upper waters that serves as the primary food source for most deep-sea life

49. Food is so rare that they must be able to swallow prey much larger than themselves whenever they encounter it

50. Black smokers are hydrothermal vents that emit dark, mineral-rich superheated water that looks like black smoke

Matching (Deep Sea Exploration): 1→D, 2→E, 3→B, 4→A, 5→C

51. B — A section of ocean where human activities like fishing and drilling are restricted or banned to protect marine ecosystems

52. C — Overfishing

53. C — Unintended marine animals caught in fishing gear, including sea turtles, dolphins, and non-target fish species

54. C — About 8%

55. C — Large plastics break down into microplastics, which are eaten by small marine organisms, then accumulate up the food chain through fish that humans

eat

56. C — Scientists must study fish reproduction rates and population sizes to determine how many can be caught without depleting the population
57. It disrupts communication, navigation, and feeding in species like whales and dolphins that rely on echolocation and vocalizations
58. An area of ocean with so little dissolved oxygen that most marine life cannot survive, caused by excess nutrient runoff triggering algae blooms that deplete oxygen when they decompose
59. Sharks control populations of mid-level predators; without sharks, those predators overpopulate and overconsume the smaller fish that commercial fisheries depend on
60. Ordinary people help collect data on marine species, pollution, and water quality over large areas that scientists alone could not monitor
Matching (Marine Conservation): 1→D, 2→B, 3→E, 4→A, 5→C
61. B — About 35 parts per thousand (3.5%)
62. B — About 8.1 (slightly basic/alkaline)
63. D — Carbon dioxide (CO₂)
64. B — About 30%
65. A — Each whole number change represents a tenfold change in acidity, so a 0.1 decrease means ocean acidity has increased by about 26%
66. A — More acidic water reduces available carbonate ions, making it harder to build shells and potentially dissolving existing ones
67. The ocean absorbs CO₂ from the atmosphere, reducing greenhouse gas levels and slowing global warming, like a sponge soaking up carbon
68. Phytoplankton absorb CO₂ for photosynthesis, and when they die, their carbon-containing remains sink to the deep ocean, storing carbon for centuries
69. Through gas exchange at the ocean surface, where gases move between the atmosphere and water based on concentration differences and water temperature
70. Sodium chloride (table salt) and magnesium chloride
Matching (Ocean Chemistry & Acidification): 1→D, 2→C, 3→B, 4→A, 5→E
71. A — Sound Navigation and Ranging

- 72. D — Remotely Operated Vehicle
- 73. C — Infrared sensors (thermal imaging satellites)
- 74. C — Niskin bottle (or CTD rosette)
- 75. A — Multibeam sends hundreds of sound beams in a fan shape, mapping a wide swath of the seafloor in one pass, while single-beam measures only one point at a time
- 76. C — Argo floats are autonomous instruments that drift at depth, periodically rising to the surface to measure temperature and salinity profiles and transmit data via satellite
- 77. GPS signals cannot penetrate seawater, so researchers use acoustic (sound) tags that transmit signals detected by underwater receivers
- 78. Organisms shed DNA into the water through skin, waste, and mucus; scientists filter water samples and analyze the DNA to identify which species are present
- 79. A CTD measures Conductivity (to calculate salinity), Temperature, and Depth continuously as it is lowered through the water column
- 80. AUVs operate independently without a tether cable, following pre-programmed routes, while ROVs are connected to a ship by a cable and controlled in real-time by an operator
Matching (Marine Technology & Research): 1→B, 2→D, 3→C, 4→A, 5→E
- 81. C — The gravitational pull of the Moon and Sun on Earth water
- 82. A — Two
- 83. A — The area of shoreline between the highest high tide and lowest low tide marks
- 84. A — An extra-high tide occurring when the Sun, Moon, and Earth align
- 85. C — A tide with the smallest difference between high and low water, occurring when Sun and Moon are at right angles
- 86. A — A rocky pool on the shore filled with seawater that remains when the tide goes out
- 87. They must survive both underwater submersion and air exposure, plus wave action and temperature changes
- 88. The Moon is much closer to Earth, and tidal force depends on distance cubed, so proximity matters more than mass

89. Higher tides and storm surges reach further inland, accelerating erosion of cliffs and beaches over time
90. Tidal range is the vertical difference between high and low tide; it varies due to coastline shape, ocean floor depth, and latitude
Matching (earth-science): 1→B, 2→E, 3→A, 4→D, 5→C
91. B — Phytoplankton and algae that convert sunlight into food through photosynthesis
92. A — A linear sequence showing how energy and nutrients pass from one organism to the next
93. B — A position in a food chain that indicates how many energy transfers separate an organism from the food chain base
94. C — A network of interconnected food chains showing multiple feeding relationships in an ecosystem
95. C — They break down dead organisms and waste, recycling nutrients back into the ecosystem
96. C — The buildup of toxic substances in an organism over its lifetime from consuming contaminated food or water
97. Energy flows upward from producers through each trophic level. Without producers, the entire food web collapses from the bottom up.
98. Only about 10% of energy transfers between trophic levels, so each higher level supports fewer organisms
99. Marine food webs have more trophic levels, rely on microscopic producers, and include filter feeders and detritivores that have no terrestrial equivalent
100. Biomagnification is the increasing concentration of toxins at each higher trophic level, while bioaccumulation is buildup within one organism
Matching (life-science): 1→C, 2→B, 3→D, 4→E, 5→A
101. C — Sonar (Sound Navigation and Ranging)
102. C — The shallow, gently sloping underwater extension of a continent
103. A — An underwater mountain chain formed where tectonic plates pull apart and magma rises to create new seafloor
104. B — Challenger Deep in the Mariana Trench at about 11,034 meters
105. A — A flat area of the deep ocean floor, typically 3,000-6,000 meters deep, covered in sediment

106. B — An opening in the seafloor where superheated, mineral-rich water escapes from Earth interior
107. It measures the time for a sound pulse to travel from the ship to the seafloor and back, then uses the speed of sound in water to calculate distance
108. Chemosynthetic bacteria at vents convert hydrogen sulfide and other chemicals into energy, forming the food chain base instead of photosynthetic organisms
109. New crust forms at mid-ocean ridges and pushes older crust outward. Magnetic stripe patterns in the rock record periodic reversals of Earth magnetic field, confirming this process.
110. Trenches form where one tectonic plate dives beneath another at a subduction zone, creating the deepest features on Earth surface
Matching (earth-science): 1→C, 2→A, 3→D, 4→B, 5→E
111. D — A scientist who studies organisms that live in the ocean and their interactions with the environment
112. D — A scientist who studies the physical, chemical, geological, and biological aspects of the ocean
113. C — A CTD instrument (Conductivity, Temperature, Depth)
114. C — A straight line or path along which organisms or conditions are systematically counted and recorded
115. C — Other experts in the same field evaluate a study methods and conclusions before it is published
116. C — A section of ocean where human activities like fishing and development are restricted to protect ecosystems
117. Long-term data reveals trends, seasonal patterns, and slow changes that single measurements miss, enabling scientists to distinguish natural variation from human-caused changes
118. Direct observation provides detailed, ground-truth data at specific locations. Remote sensing (satellites, sonar) covers vast areas efficiently. Combining both provides comprehensive understanding.
119. Volunteers collect data across large areas and time periods that professional scientists could not cover alone, expanding the geographic and temporal scale of research
120. A hypothesis is a testable prediction about a specific observation. A theory is a well-tested, broad explanation supported by extensive evidence from many

studies.

Matching (earth-science): 1→D, 2→E, 3→A, 4→B, 5→C

- 121. D — Sunlight, Twilight, Midnight, Abyssal, Hadal
- 122. A — Color-changing skin for camouflage, flexible body to hide in small crevices, and intelligence to solve problems like opening shells for food
- 123. C — Evaporation from warm ocean surfaces adds moisture to the atmosphere, which falls as rain/snow, runs into rivers, flows back to the ocean, and currents redistribute this water and heat globally
- 124. C — Removing predators like giant triton snails allows starfish populations to grow unchecked, leading to outbreaks that devastate coral
- 125. D — What species live at the site? How will sediment plumes affect organisms? How long will ecosystem recovery take? Has an independent environmental review been conducted? What monitoring will occur?
- 126. D — An area of ocean with so little dissolved oxygen that most marine life cannot survive, caused by excess nutrient runoff triggering algae blooms that deplete oxygen when they decompose
- 127. Past pH changes occurred over millions of years, allowing evolution. Current acidification is happening 100 times faster, giving organisms insufficient time to adapt, and past rapid acidification events did cause mass extinctions
- 128. Argo provides continuous, global subsurface ocean data in near-real-time, revealing that the deep ocean absorbs significant excess heat and that warming extends far below what ships could measure in limited locations
- 129. The twilight zone has dim, faint light while the midnight zone has no light at all

- 130. Coral reef

Matching (Ocean Currents & Tides): 1→A, 2→C, 3→B, 4→D, 5→E

- 131. B — Hadal zone (hadalpelagic)
- 132. D — Crustaceans (such as crabs or lobsters)
- 133. B — Warm currents bring mild, moist weather to nearby coasts, while cold currents bring cooler, drier conditions and often fog
- 134. C — Strengths: can breed heat-resistant coral and restore damaged areas.
Limitations: expensive, slow, and does not address root causes like warming and pollution
- 135. D — Both face extreme pressure differences, require life support, and involve

vast unknown areas, but deep-sea pressure crushes inward while space pressure pushes outward, and communication is harder in the ocean than in space

136. D — While cleanup helps, it is not the most effective solution -- preventing plastic from entering the ocean through source reduction, better waste management, and policy changes addresses the root cause
137. While limestone does neutralize acid, the scale required is impractical -- billions of tons would be needed, mining would cause environmental damage, and it does not address the root cause of excess CO₂ emissions
138. eDNA allows rapid, non-invasive biodiversity surveys by analyzing water samples instead of time-consuming visual surveys, enabling more frequent monitoring of more species across larger areas
139. Both are important: the sunlight zone produces most oxygen and food, while deep zones hold undiscovered species and geological secrets
140. Because Earth's rotation deflects moving water to the right in the Northern Hemisphere
Matching (Ocean Currents & Tides): 1→A, 2→C, 3→D, 4→E, 5→B
141. D — Estuary
142. B — Ocean gyres create circular currents that trap floating debris in their calm centers
143. C — Assess damage to reef biodiversity, loss of coastal storm protection, impact on local fisheries, sediment runoff effects, and long-term economic value of the intact reef
144. B — Aquaculture can reduce pressure on wild populations but raises concerns about water pollution, disease spread to wild fish, habitat destruction, and feed sourcing from wild fish stocks
145. C — The shell in acidic water would be thinner, lighter, and possibly pitted or partially dissolved compared to the shell in normal seawater
146. C — Deploy a network of moored sensor buoys measuring pH, temperature, salinity, dissolved oxygen, and turbidity, with solar-powered satellite data transmission and periodic calibration visits
147. Sunlight zone (epipelagic)
148. The deep sea lacks sunlight for photosynthesis, so food is extremely scarce compared to sunlit coral reefs
149. They transport warm water from the equator toward the poles and cold water

toward the equator, distributing heat around the planet

150. The reef is bleaching from heat stress; they should monitor water temperature and whether zooxanthellae return to corals within weeks
Matching (Ocean Currents & Tides): 1→D, 2→A, 3→E, 4→B, 5→C
151. B — Combining both depth and organisms gives the most complete classification
152. A — A global system of deep and surface ocean currents that circulates water around the world over about 1,000 years
153. D — Coastal development causes sediment runoff, sewage discharge, overfishing, anchor damage, and pollution that all degrade nearby reefs
154. B — Openings in the ocean floor where geothermally heated water erupts into the cold deep sea
155. C — Create zoned MPAs (no-take core with sustainable fishing zones), develop eco-tourism, invest in sustainable aquaculture, train fishers as marine guides, and establish community-led management
156. D — Phytoplankton (producer) > krill (primary consumer) > mackerel (secondary consumer) > dolphin (tertiary consumer), with bacteria as decomposers
157. Clockwise, circling the North Atlantic Ocean
158. About 25%
159. A pressure-resistant habitat with life support (oxygen, CO₂ removal, temperature control), docking for submersibles and ROVs, observation windows, communication systems, and emergency escape capabilities
160. Through gas exchange at the ocean surface, where gases move between the atmosphere and water based on concentration differences and water temperature
Matching (Ocean Currents & Tides): 1→E, 2→B, 3→C, 4→A, 5→D
161. They have their own scales!
162. Nothing -- it just waved!
163. They're well armed!
164. I tried to write a joke about the ocean floor, but it was too deep.
165. A fsh!
166. It felt the relationship was getting too symbiotic!
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