The Last Frontier

The area of the Earth is over 197,000,000 square miles. Of that, less than one-third is land while 71% of the planet is covered by water, most of which is salt water. Only 3% of the total water area is fresh water; the remaining 97% is salt water.

Five major oceans account for the majority of the salt water that covers the Earth’s surface. From largest to smallest they are the Pacific, the Atlantic, the Indian, the Southern, and the Arctic. Until 2000, there were only four officially recognized oceans. In 2000, the International Hydrographic Organization established the Southern Ocean, a circumpolar ocean that encircles Antarctica, it includes the waters below 60 degrees south latitude.

The oceans are divided into five distinct layers or zones which vary from sunny to pitch black, from warm to icy cold, from turbulent to calm, from very little pressure to bone-crushing pressure¹.

The first layer, which is from the ocean’s surface to a depth of 660 feet, is called the sunlight zone (Epipelagic zone). It is at this level that the majority of ocean life exists. The water in this zone is in constant motion. It is warm and well lit due to the sun. Temperatures in this zone may range from 97°F (close to the equator) to 27°F (at the polar regions). The blue marlin, dolphin, flying fish, kelp, and several species of turtle are among the many life forms found in this zone.

The second layer of the ocean waters is the twilight zone (Mesopelagic zone). Between 660 to 3,300 feet, only half the amount of light penetrates to this depth. The temperature range and changes are quite drastic in this zone. Temperatures can be as low as 41°F and pressure is much greater. The fish that live in this zone often have bioluminescence or “body lights” along their bodies and tails, and they have very large eyes. Flashlight fish, oarfish, sea lilies, and sea squirts are among the ocean life found in the twilight zone.

Beneath the twilight zone is the midnight zone (Bathypelagic zone), which extends to 13,100 feet. Temperatures in this zone are fairly constant,¹

¹ Pressure increases by 1 atm (14.7 psi) for every 33 ft. of depth. At sea level there is 14.7 pounds per square inch of pressure. Since water is much heavier than air, this pressure increases as we venture into the water. For every 33 feet down we travel, one more atmosphere (14.7 psi) pushes down on us. For example, at 66 feet, the pressure equals 44.1 psi, and at 99 feet, the pressure equals 58.8 psi.
staying around 37°F. The water pressure in this zone can be up to one thousand times as great as the pressure on the surface. Sunlight cannot penetrate to this depth so there are no plants and very little food available for the fish that live in this zone. The only light is that which is produced by the creatures themselves. Most of the fish found here are red or black in color due to the lack of light. Those that do live here usually have very large mouths that can stretch, helping them to trap whatever comes their way. The gulper eel survives well in this zone. The lantern eel and some squid also spend their days here only to surface at night in search of food. The sperm whale is known to dive to these depths in search of food, but it does prefer to spend its time closer to the sunlight zone.

Between 13,100 to 19,700 feet below the surface is the abyss (Abyssopelagic zone). The abyssal plains cover almost half of the ocean floor. The water at this level is very still, dark, and cold (a constant 33°F). The floor is a thick mud made from the skeletons of dead sea animals and plants. In some places, the mud is more than a mile thick. Because of the absolute darkness, the near freezing temperatures, and the extreme pressure, the sea creatures that live here are few and they often may not have eyes since they would be of no use. Deep sea prawns, the brittle starfish, and the anemone can be found in the abyssal plains. Scientists are just beginning to explore the ocean at this depth.

The final level is the trenches (Hadalpelagic zone). Trenches extend from 19,700 feet downward. The deepest trench is the Mariana Trench located off the Mariana Islands near Japan. The Mariana Trench at 35,840 feet, almost seven miles, is the deepest place on Earth. The trenches are ice cold and pitch black. Only specially adapted creatures such as starfish, tubeworms, and some other invertebrates are able to withstand the extreme conditions and the scarcity of food at this depth. The pressure in the trenches is eight tons per square inch. Scientists are also just beginning to learn more about life at this level.

The ocean is often referred to as the last frontier. Though most of the Earth is covered by ocean waters, scientists know very little about life below the sunlight zone. Submersibles that can dive to the very depths of the ocean floor are being developed and perfected, and it is hoped that within the next decade scientists will uncover some of the mysteries of the very deepest, darkest regions of the Earth.
LAYERS OF THE OCEAN

- **Epipelagic Zone (The Sunlight Zone)**
- **Mesopelagic Zone (The Twilight Zone)**
- **Bathypelagic Zone (The Midnight Zone)**
- **Abyssopelagic Zone (The Abyss)**
- **Hadalpelagic Zone (The Trenches)**

**Continental Shelf**: 3,300 ft
**Continental Slope**: 6,600 ft
**Continental Rise**: 9,900 ft
**Ocean Basin**: 13,100 ft
**Ocean Trench**: 16,300 ft
**Ocean Trench**: 19,700 ft
**Ocean Trench**: 23,000 ft
**Ocean Trench**: 26,300 ft
**Ocean Trench**: 29,600 ft
**Ocean Trench**: 32,800 ft
**Ocean Trench**: 36,100 ft
The Last Frontier

1. Read the phrase from the passage.

...vary from sunny to pitch black, from warm to icy cold, from turbulent to calm...

Using context clues, what is the best definition for the word turbulent?

- A peaceful
- B confused
- C predictable
- D violent

2. Read the phrase from the passage.

...the Southern Ocean, which is a circumpolar ocean...

Using context clues and your knowledge of root words and affixes, what is the best definition for the word circumpolar?

- A separates the polar region
- B surrounds the polar region
- C runs through the polar region
- D floods the polar region

3. Which statement explains why the oceans are often referred to as “the last frontier”?

- A People still have much to learn about the ocean.
- B The oceans can be unpredictable and dangerous.
- C Scientists want to find a way to conquer the oceans.
- D Ocean life is very fragile and scientists want to protect it.
4. All of the following statements about the ocean are true except --
   - A The greater the depth, the greater the pressure.
   - B The greater the depth, the warmer the water.
   - C The greater the depth, the calmer the water.
   - D The greater the depth, the darker the environment.

5. Why are there no green plants found below the Mesopelagic zone?
   - A The water at such depths is too cold to support plant life.
   - B The fish have eaten all the plant life in the midnight zone.
   - C There is no sunlight below the Mesopelagic zone.
   - D The pressure so great it crushes the plants.

6. Which of the following is not a logical conclusion based on the information in the passage?
   - A Scientists hope to someday build “homes” on the floor of the ocean and live there.
   - B The sea life found at 19,000 feet is quite different from the sea life which lives in the Epipelagic zone.
   - C Scientists will continue to explore the oceans over the next several years.
   - D Special equipment that can withstand conditions below the sunlight zone is required for ocean exploration.

7. Which statement best summarizes the main idea of the passage?
   - A Oceans cover over 70% of the Earth while only about 30% of the Earth is land.
   - B Scientists recently discovered a new body of salt water near the Antarctica.
   - C Each of the five layers of the ocean has its own environmental characteristics and life forms.
   - D High-tech submersibles are being built that will allow scientists to explore the deepest parts of the ocean.
8. Complete the chart below using information from the passage. You will have to calculate and round the pressure for each zone.

\[
66 \text{ ft.} \quad = \quad \frac{660 \text{ ft}}{44.1 \text{ psi} \times \text{psi}}
\]

<table>
<thead>
<tr>
<th>ZONE</th>
<th>DEPTH and PRESSURE</th>
<th>TEMPERATURE</th>
<th>LIGHT</th>
<th>LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epipelagic</td>
<td>0 – 660 ft.</td>
<td>97°F - 27°F</td>
<td>Sunlight</td>
<td>Plant life, marlin, turtles, dolphin,</td>
</tr>
<tr>
<td>(Sunlight)</td>
<td>14.7 psi – 441 psi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesopelagic</td>
<td>13,100 – 19,700 ft.</td>
<td>37°F (constant)</td>
<td>Prawns, starfish, anemone</td>
<td></td>
</tr>
<tr>
<td>(Twilight)</td>
<td></td>
<td></td>
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<td></td>
</tr>
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9. What organizational structure is used to develop this passage?
   - A  cause and effect
   - B  chronological
   - C  compare and contrast
   - D  logical order

Is this the best organizational structure to use for this passage? Defend your answer.

________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
The Last Frontier

Reading
1. D  S1 C4 PO2
2. B  S1 C4 PO1 and S1 C4 PO2
3. A  S1 C4 PO4
4. B  S3 C1 PO5
5. C  S3 C1 PO5
6. A  S3 C1 PO9 (grade 6)  S3 C1 PO10 (grade 7)
7. C  S3 C1 PO2
8. S3 C1 PO5  Math gr 6 S1 C2 PO14; gr 7 S1 C2 PO4 & 5

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</tr>
<tr>
<td>Mesopelagic</td>
<td>660 – 3,300 ft. 441 -2205 psi</td>
<td>As low as 41°F</td>
<td>Partial/Half sunlight</td>
<td>Flashlight fish, oar fish, sea lilies, sea squirts</td>
</tr>
<tr>
<td>(Twilight)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Bathypelagic</td>
<td>3,300 – 13,100 ft. 2205 – 8753 psi</td>
<td>37°F (constant)</td>
<td>Only light from fish - bioluminescence</td>
<td>Lantern eel, gulper eel, many fish will be red or black</td>
</tr>
<tr>
<td>(Midnight)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abyssopelagic</td>
<td>13,100 – 19,700 ft. 8753 – 13163 psi</td>
<td>33°F (constant)</td>
<td>Pitch black</td>
<td>Prawns, starfish, anemone</td>
</tr>
<tr>
<td>(Abyss)</td>
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<tr>
<td>Hadapalagic</td>
<td>19700 – 35840 ft 13163 – 23947 psi</td>
<td>Ice cold – (unless volcanic activity)</td>
<td>Pitch/absolute black/dark</td>
<td>Starfish, tubeworms – other life forms to be discovered</td>
</tr>
<tr>
<td>(Trenches)</td>
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9. D  S3 C1 PO8 (grade 6)  S3 C1 PO9 (grade 7)  Yes, systematically takes reader from surface to bottom. Makes it easier to understand, visualize, and organize information.