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**Oceanography**

**Main Ideas**

* Oceanography is the scientific study of Earth’s oceans.
* Oceans explored by:
  + Sonar
  + Satellites
  + Submersibles

**Scientists theorize that:**

* First oceans formed over 1.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years ago
  + Some water from impacting comets
  + From deep within Earth’s interior released by volcanism.
  + Most was water vapor in atmosphere and Earth finally cooled enough for water to condense into liquid and rain back down to Earth.
* Approx. 2.)\_\_\_\_\_\_\_percent of Earth is covered by oceans.
* Major oceans
  + Pacific
  + Atlantic
  + Indian
  + Arctic
  + Antarctic.
* 3.)\_\_\_\_\_\_\_\_\_\_\_ - Largest, contains half of all seawater and is larger than all Earth’s landmasses combined.
* Atlantic - extends from Antarctica to the arctic circle
* Indian - located mainly in the southern hemisphere.
* Seawater
  + 4.)\_\_\_\_\_\_\_\_\_\_ water & 5.)\_\_\_\_\_\_\_\_\_\_\_\_ salt.
  + Avg. salinity- 35 ppt.
* Ocean surface temps are –2°C to 30°C.
* Seawater density changes when salinity and/or temperature change.

**Ocean Temperatures**

* Temperatures decrease with depth.
* 3 layers of the ocean:
  + surface layer
  + transitional 6.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Deep Zone

**Ocean Temperatures and Circulation**

* Density Currents
  + As sea ice forms, most salt is forced out of the freezing water.
  + The cold water around the ice becomes saltier and denser and sinks
  + Cold water moves toward the equator along 7.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Wind-driven surface currents affect the upper few hundred meters of the ocean.
  + Upwelling occurs when winds push surface water aside and the surface water is replaced by cold, deep water.
  + 8.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - when this upwelling fails to occur in the pacific ocean off the coast of South America.
    - Alters weather patterns around the world
    - Believed to 9.)\_\_\_\_\_\_\_\_\_\_\_\_ the number of hurricanes in the Atlantic

**Gyres (“J-eye-ers”)**

* The oceans contain 10.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, called gyres.

**5 major gyres:**

1. North Pacific
2. North Atlantic
3. South Pacific
4. South Atlantic
5. Indian Ocean

What direction do the gyres turn?

What might cause this?

**Ocean Waves**

* Ocean waves caused by wind. **Wave** - rhythmic movement that carries energy through matter or space
* Water in a wave moves in a 11)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_; It does not move forward.
* When waves reach shallow water, friction with the bottom slows them, and they break.
* **Breaker** - collapsing wave that forms when a wave reaches shallow water

**Ocean Tides**

* Caused by gravitational attraction among Earth, Moon, and Sun.
  + Lunar tides are twice as high as solar tides.

**12.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* Sun, Moon, Earth aligned
* high tides - higher than normal
* low tides - lower than normal.

**13.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* high tides - lower than normal
* low tides - higher than normal.

**Shorlines**

**Erosional Landforms**

* Waves increase in height and become breakers as they approach a shoreline.
* The energy in large breakers, together with suspended rock fragments, can erode solid rock.
* Waves move faster in deep water than in shallow water.
* Wave refraction is a process that causes initially straight wave crests to bend when part of the crest moves into shallow water due to the difference in wave speed.
* Along an irregular coast the wave crests bend towards the headlands concentrating most of the breaker energy along the relatively short section of the shore around the tips of the headlands.
* Given enough time, irregular shorelines are straightened by wave action.

**Landforms of Rocky Headlands**

* Generally, as a headland is gradually worn away, a flat erosional surface called a 14.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_is formed.
* The wave-cut platform terminates against a steep wave-cut cliff.
* Differential erosion, the removal of weaker rocks or rocks near sea level, produces 15.)\_\_\_\_\_\_\_\_\_\_\_\_\_, sea arches, and sea caves.

**Beaches**

* A beach is a sloping band of sand, pebbles, gravel, or mud at the edge of the sea.
* Beaches are composed of loose sediments deposited and moved about by waves along   
  the shoreline.
* The size of sediment particles depends on the energy of the waves striking the coast and on the source of the sediment.

**Longshore Currents**

* The 16.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a sand bar that forms in front of most beaches.
* Waves break on the longshore bar in the area known as the 17.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The longshore trough is the deeper water closer to shore than the longshore bar.
* The longshore current is a current flowing 18.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_to the shore that is produced as water from incoming breakers spills over the longshore bar.

**Movement of Sediments**

* Longshore currents move large amounts of sediments along the shore.
* Fine-grained material such as sand is suspended in the turbulent, moving water, and larger particles are pushed along the bottom by the current.
* The transport of sediment is in the direction of the longshore current, generally to the 19.)\_\_\_\_\_\_\_\_\_\_\_ on the Atlantic and Pacific Coasts of the United States.

**Rip Currents**

* Wave action also produces rip currents, 20.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* These dangerous currents can reach speeds of several kilometers per hour.
* If you are ever caught in a rip current, you should not try to swim against it, but rather swim parallel to the shore to get out of it.

**Depositional Features of Seashores**

* Sediments moved and deposited by longshore currents build various characteristic coastal landforms.
* A 21.)\_\_\_\_\_\_\_ is a narrow bank of sand that projects into the water from a bend in the coastline.
* A baymouth bar forms when a growing spit crosses a bay.
* Barrier islands are long ridges of sand or other sediment, deposited or shaped by the longshore current, that are separated from the mainland.

**Depositional Features of Seashores**

* The shallow, protected bodies of water behind baymouth bars and barrier islands are called 22.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* A 23.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a ridge of sand that forms between the mainland and an island, and connects the island to the mainland.
* All depositional coastal landforms, including large barrier islands, are unstable and temporary.
* Tides, currents, storm waves, and winds all play a role in building coastal features that rise well above sea level.

**Protective Structures**

* One way to repair the damage cause by beach erosion without building protective structures is through Beach Nourishment
* Beach Nourishment is when new sand is imported (brought into) either by truck and inland sources or dredged (pumped up from the ocean bottom).
* 24.)\_\_\_\_\_\_\_\_\_\_\_\_\_ are built protect beachfront properties from powerful storm waves by reflecting the energy of such waves back towards the beach.
* 25.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are wall-like structures built into the water perpendicular to the shoreline for the purpose of trapping beach sand.
* 26.)\_\_\_\_\_\_\_\_\_\_\_ are walls of concrete built to protect a harbor entrance from drifting sand.
* 27.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are built in the water parallel to straight shorelines to provide anchorages for small boats.
* The longshore current slows down behind the breakwater and is no longer able to move its load of sediment, which is then deposited behind the breakwater.
* If the accumulating sediment is left alone, it will eventually fill the anchorage.

**Changes in Sea Level**

* In the last 100 years, the global sea level has risen 10 to 15 cm and estimates suggest a continued rise in sea level of 1.5 to 3.9 mm/year.
* Many scientists contend that this continuing rise in sea level is the result of 28.)\_\_\_\_\_\_\_\_\_\_\_\_.
* As Earth’s surface temperature rises, seawater will warm and 29.)\_\_\_\_\_\_\_\_\_\_\_and water flow into the oceans from melting glaciers will increase.
* Scientists predict that global sea levels could rise another 30.)\_\_\_\_\_\_\_\_\_in the next 70 years.

**Effects of Sea Level Changes**

* Although unlikely anytime soon, if Earth’s remaining polar ice sheets melted completely, their meltwaters would raise sea level by 31.)\_\_\_\_\_\_\_\_\_\_.
* This rise would totally flood some countries, such as the Netherlands, along with some coastal cities in the United States, such as New York City, and low-lying states such as Florida and Louisiana.
* If Earth’s temperature keeps rising, an unstable part of the Antarctic ice sheet eventually could melt and cause a rise in sea level of about 32.)\_\_\_\_\_\_\_\_\_\_\_.

**Effects of Tectonic Forces**

* Tectonic sinking along a coastline causes a relative rise in sea level along that coast.
* Tectonic uplift along a coastline produces a relative drop in sea level.
* Much of the United States West Coast is being 33.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the sea level is rising.
* Because much of the West Coast was formerly under water, it is called an 34.)\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Emergent coasts tend to be relatively straight because the exposed seafloor topography is much smoother than typical land surfaces.

**Oceanic and Continental Crust**

* Earth has two types of crust: 35.)\_\_\_\_\_\_\_\_\_ continental crust and 36.)\_\_\_\_\_\_\_\_ oceanic crust.
* Crustal elevation depends on crustal thickness.
* Continental 37.)\_\_\_\_\_\_\_\_\_\_\_\_\_ are submerged parts of continents that include the continental shelf, the continental slope, and the continental rise.

**Continental Shelves**

* The continental margins are the areas where the edges of continents meet the ocean.
* The continental shelf is the 38.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of a continental margin extending seaward from the shore.
* The average depth of the water above continental shelves is about 130 m, thus most of the world’s continental shelves were 39.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Continental shelves are home to large numbers of commercially valuable fishes.
* Thick sedimentary deposits on the shelves are also significant sources of 40.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* 41.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are where the seafloor drops away quickly to depths of several kilometers marking the edge of the continental crust.
* In many places, this slope is marked by deep canyons that were cut by turbidity currents.
* Turbidity currents are rapidly flowing water currents along the bottom of the sea that carry heavy loads of sediments, similar to mudflows on land.
* The sediments carried down the continental slope by these currents eventually come to rest at the bottom of the slope and beyond.
* A 42.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a gently sloping accumulation of deposits from turbidity currents that forms at the base of the continental slope.
* In some places, especially around the 43.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the continental slope ends in deep-sea trenches and there is no continental rise.
* Ocean basins are deeper parts of the seafloor that lie above the thin, basaltic, oceanic crust beyond the continental margin.
* Ocean basins represent about 44.)\_\_\_\_\_percent of Earth’s surface and contain some of Earth’s   
  most interesting topography.

**Ocean Basins**

**Abyssal Plains**

* The abyssal plains are 45.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_below sea level.
* Abyssal plains are plains covered with hundreds of meters of fine-grained muddy sediments and sedimentary rocks that were deposited on top of basaltic volcanic rocks.

**Deep-Sea Trenches**

* Deep-sea trenches are elongated, sometimes arc-shaped depressions in the seafloor several kilometers deeper than the adjacent abyssal plains.
* Many deep-sea trenches lie next to 46.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and most of them are located around the margins of the Pacific Ocean.

**Mid-Ocean Ridges**

* Mid-ocean ridges are 47.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_that run through all the ocean basins and have a total length of over 65 000 km.
* Mid-ocean ridges have an average height of 1500 m, but they may be thousands of kilometers wide.
* Mid-ocean ridges are sites of frequent volcanic eruptions and earthquake activity.
* The crests of these ridges often have valleys up to 2 km deep, called 48.)\_\_\_\_\_\_, running through their centers.
* Instead of forming continuous lines, the mid-ocean ridges break into a series of shorter, stepped sections called fracture zones, which run at right angles across each mid-ocean ridge.
* Fracture zones are about 60 km wide, and they curve gently across the seafloor, sometimes for thousands of kilometers.

**Hydrothermal Vents**

* A hydrothermal vent is a hole in the seafloor through which fluid heated by magma erupts.
* Most hydrothermal vents are located along 49.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* A 50.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is type of hydrothermal vent that ejects superheated water containing metal oxides and sulfides that produce thick, black, smokelike plumes.
* A white smoker ejects warm water.

**Seafloor Volcanoes**

* Most of the mountains on the seafloor are probably extinct volcanoes.
* There are two types of extinct seafloor volcanoes: seamounts and guyots.
* Seamounts are submerged basaltic volcanoes more than 1 km high.
* Guyots, also called tablemounts, are large, extinct, basaltic volcanoes with51.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Unlike features on land, seafloor structures persist practically forever due to a lack of erosional mechanisms.

**Marine Sediments**

* Most of the sediments that cover the ocean floor come from the continents.
* Much of the coarser material supplied by rivers settles out near shorelines or on beaches.
* The dominant type of sediment on the deep ocean floor is fine-grained, deep-sea mud.
* Some sandy sediments occasionally reach the abyssal plains in particularly strong turbidity currents.

**Ooze**

* The shells and hard parts of marine organisms are another major source of deep-sea sediments.
* Sediments containing a large percentage of particles derived from once-living organisms are called oozes.
* Most of these particles are small and consist of either 52.)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The oozes and deep-sea muds of the deep ocean typically accumulate at a rate of only a few millimeters per thousand years.

**Manganese Nodules**

* Manganese nodules consist of oxides of 53.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and other valuable metals that precipitated directly from seawater.
* Their growth rates are measured in millimeters per million years.
* Manganese nodules cover huge areas of the seafloor.