



In Instruction 2, we told you about the temperature zones in the Earth's oceans: the Surface Zone, the Thermocline and the Deep Zone.

We also discussed ocean currents.

Now we'd like to talk about ocean water itself and its *chemical and physical properties*.

Ninety-nine percent of all the water on Earth is ocean water.

Chemical Properties

Ocean water is made up of 96.5% water (H₂O, an oxide of hydrogen) and 3.5% solids.

The main chemical ingredient in these solids is salt (sodium chloride, NaCl), a simple chemical compound found in the tissue of all living organisms. Other chemicals include Magnesium, Sulfate, Calcium, Potassium, Carbon, Bromine, Boron, Strontium, Fluorine and ions of Nitrogen.

Since most scientists agree that life began in the sea, it is not surprising that a number of these chemicals (Magnesium, Sulfate, Calcium, Potassium, Carbon and the Nitrogen ions) are essential to life.

Now let's discuss the *physical* properties of ocean water.

Physical Properties

Density

One of the most important physical properties of ocean water is its weight, or density.

Density mainly depends on two things -- temperature and salinity (the amount of salt that's dissolved in the water).

The density of ocean water ranges from 1.026 to 1.028 grams per centimeter.

High-salinity seawater is denser than low-salinity seawater. Cold seawater is denser than warm seawater.



So the highest-density seawater is *cold, high-salinity seawater*.

Density is affected by pressure, too -- which increases rapidly with depth. But pressure has little effect on circulation, which is what we're mostly concerned with in this Lesson.

Salinity

Salinity, as we said, is the amount of salt that's dissolved in an ocean's water -- and it's different in different places.

The salinity of ocean water varies between 3.0 and 3.7 percent, so it averages out at about 3.5%.

Salinity is primarily determined by the balance between evaporation and precipitation.

Ocean water is saltier where there is high evaporation, low rainfall and warm water. And less salty where large rivers flow into the ocean, where there is high rainfall or where there is melting ice.

The combination of salinity and temperature has a profound effect on the circulation of the oceans.

Temperature

The temperature of ocean water is highest at the Equator (where it is warmed by the Sun) and coldest toward the poles.

Compared to air, water has an extremely high heat capacity, so it takes more sunlight to warm it up.

Fortunately, warm seawater is lighter than cool seawater, so the warm water usually stays on top.

As we told you in Instruction 2, there are three temperature zones in the oceans (although they can vary from season to season). They are:

The Surface Zone (which begins at the Earth's surface and goes down to about 400 meters). This accounts for about 10% of the Earth's oceans. The average year-round temperature in the Surface Zone is 22 degrees Celsius.



The Thermocline (which is the zone of separation between The Surface Zone and the next zone down, the Deep Zone). It begins at about 400 meters and extends down to about 800 meters. Temperatures in the Thermocline drop rapidly from warm surface conditions to frigid deep-water conditions.

The Deep Zone (which starts at about 800 meters and extends down to the ocean floor). Temperatures in the deep zone hover just above the freezing point of water (0-4 degrees Celsius).

Differences in temperature -- along with wind, salinity, the topography of the ocean floor and the rotation of the Earth -- are what causes the circulation of water in the ocean (the ocean currents). We covered currents in Instruction 2, but now might be a good time to review it.

We will, however, summarize the three main types of currents.

Ocean Currents

Surface Currents

Surface currents are parts of the upper ocean that move continuously in a specific direction.

Some are powered by wind and move in the same pattern as the winds do, while others distribute heat from warmer areas to cooler ones.

Density Currents

Density Currents are caused by the differences in density in various parts of the oceans. Water tends to move from areas of high density to areas of lower density.

At the poles, for example, ice forms and leaves salt behind in the remaining unfrozen water. This cold, dense, salty water sinks and flows toward the Equator.

Upwelling

Often, when winds blow surface water away from the edges of a continent, deep water rises to replace it.

The current that brings this deep cold water to the surface is called an Upwelling.



Waves

Waves are regular disturbances that carry energy through water. They are caused by wind blowing across the surface of the water.

Earthquakes can cause mammoth waves called *tsunamis*.

A *breaker* is a wave that forms a sharp peak and then falls forward as it reaches the shore. It is caused when friction with the ocean bottom slows down the bottom of the wave so its top outruns its bottom.

Here are a few words to remember about waves:

Crest	the high point of a wave
Trough	the low point of a wave
Wave Length	the distance between a specific point on one wave and the exact same point on the next one
Wave Height	the distance between the crest and the trough of a wave

Tides

The Tides are the daily rise and fall of the water level caused by the gravitational pull of the Sun and the Moon on the oceans.

One Low-Tide-High-Tide cycle is about 12 hours and 25 minutes.

High Tide is the highest level that the ocean reaches on shore.

Low Tide is the lowest level that the ocean reaches on shore.

Here are some special effects caused on the Earth by the Moon:

The Moon pulls the oceans toward itself causing a bulge on the side closest to the Moon.



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It also pulls the Earth toward itself causing a bulge in the side away from the Moon.

Here are some special effects caused by the Sun:

Spring Tides (caused when the Sun and Moon are lined up with the Earth, at Full and New Moon): the High Tides are higher and the Low Tides are lower.

Neap Tide (caused when the Sun and Moon are at right angles to each other, at First and Third Quarter): the High Tides are lower and the Low Tides are higher.