Name _____ Class _____ Date _____

CHAPTER 24 Ocean Water

SECTION 1

# Properties of Ocean Water

**KEY IDEAS**

**As you read this section, keep these questions in mind:**

- What is the chemical composition of ocean water?
- What are the salinity, temperature, density, and color of ocean water?

## What Are the Properties of Ocean Water?

Pure liquid water has no taste, smell, or color. However, the liquid water in the ocean is not pure. Many solids and gases dissolve in ocean water. Ocean water also contains small, solid particles and tiny organisms.

Ocean water is a complex mixture of chemicals. It supports many different *organisms*, or living things. Scientists study properties of ocean water to understand how the ocean, atmosphere, and land interact. Some properties of ocean water that scientists study are

- chemical composition
- salinity
- temperature
- density
- color. ☑

**READING TOOLBOX**

**Analyze Comparisons** As you read, list examples of comparisons in this section. Identify the objects or conecpts being compared and the signal word or phrase. Signal words for comparisons include *more than* and *less than.*

**READING CHECK**

**1. List** Name three properties of ocean water.

_____

_____

_____

## What Gases Dissolve in Ocean Water?

The two main gases in the atmosphere are nitrogen, $N_2$, and oxygen, $O_2$. Nitrogen and oxygen are also the main gases dissolved in ocean water. Other gases from the atmosphere are present in ocean water in small amounts. Ocean water also has a large amount of dissolved carbon dioxide, $CO_2$. ☑

### SOURCES OF DISSOLVED GASES

The dissolved gases in ocean water come from many sources. Gases may enter ocean water from streams and rivers. Some gases come from volcanic eruptions under the ocean. Organisms in the ocean also release gases into ocean water. For example, marine organisms that carry out photosynthesis release oxygen into the ocean water. However, most gases in the ocean come from the atmosphere.

**READING CHECK**

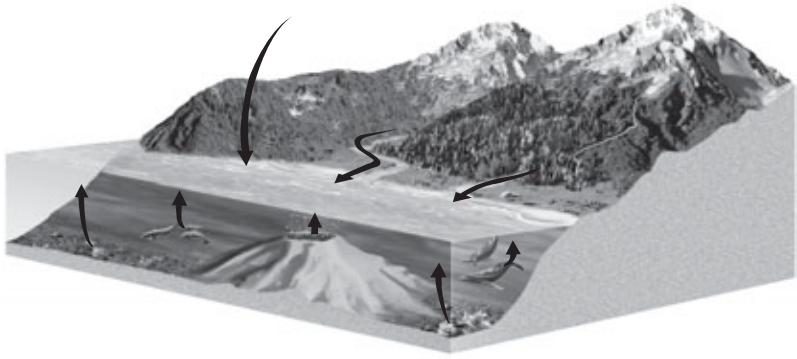
**2. Identify** What are the two main gases dissolved in ocean water?

_____

_____

## LOOKING CLOSER

**3. Identify** On the diagram, label four sources of dissolved gases in the oceans.



Dissolved gases affect the chemical composition of ocean water.

### TEMPERATURE AND DISSOLVED GASES

The temperature of water affects how much gas dissolves in the water. More gas can dissolve in cold water than in warm water. As a result, surface water in cold regions can hold more dissolved gas than water in warm regions can.

Gases can return to the atmosphere from the ocean. If the water temperature rises, the water releases extra gases into the atmosphere. For example, warm oceans near the equator release $CO_2$ into the atmosphere. Oceans in cooler regions dissolve large amounts of $CO_2$. Therefore, the ocean and the atmosphere constantly exchange gases as water temperature changes.

## Critical Thinking

**4. Apply Concepts** Why would surface water in the North Atlantic Ocean probably have more dissolved gases than surface water in the Caribbean Sea?

_____

_____

_____

_____

### THE OCEAN AS A CARBON SINK

The ocean contains more than 60 times as much carbon as the atmosphere does. The ocean may trap dissolved $CO_2$ for hundreds to thousands of years. The ocean is often called a *carbon sink* because it can store so much $CO_2$ ☑.

**READING CHECK**

**5. Explain** Why is the ocean called a *carbon sink*?

_____

_____

_____

As a carbon sink, the ocean helps control Earth's climate. The amount of $CO_2$ in the air affects how the atmosphere traps heat from the sun. The ocean changes the amount of $CO_2$ in the air when it dissolves $CO_2$. Therefore, the ocean affects the movement of heat in Earth's atmosphere.

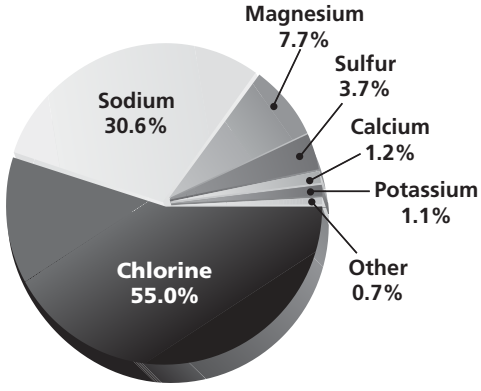
## What Solids Dissolve in Ocean Water?

Ocean water is 96.5% pure water, or $H_2O$. Dissolved solids make up about 3.5% of the mass of ocean water. These dissolved solids are often called *sea salts*. Sea salts give the ocean its salty taste.

### COMPOSITION OF DISSOLVED SOLIDS

About 75 chemical elements make up the sea salts in ocean water. The six most abundant elements in sea salts are chlorine, sodium, magnesium, sulfur, calcium, and potassium. Sodium and chlorine combine to form the salt halite. Halite makes up more than 85% of sea salt.

The remaining dissolved solids are made of other salts and minerals, as shown below. *Trace elements* are elements that exist in very small amounts. Gold, zinc, and phosphorous are trace elements in the ocean.




This chart shows the most abundant elements in the dissolved solids in ocean water.

**LOOKING CLOSER**

**6. Identify** What is the most abundant element in sea salts?

_____

### SOURCES OF DISSOLVED SOLIDS

The elements that form dissolved solids come from three main sources:

- volcanic eruptions
- chemical weathering of rock on land
- chemical reactions between water and new sea-floor rocks

Rivers carry about 400 billion kilograms of dissolved solids into the ocean each year. Most of these dissolved solids are salts. As water evaporates from the ocean, sea salts stay in the ocean. Rain and snow return a very small amount of these salts to the land.

## What Is Salinity?

**Salinity** is a measure of the amount of dissolved solids in a liquid. For example, 1,000 g of ocean water may contain 35 g of solids. The salinity of this water would be written as 35 parts per thousand (ppt), or 35‰. Ten parts per thousand equals 1%. Thus, the ocean is about 3.5% salts. Fresh water is less than 0.1% salts. That is, it has a salinity of less than 1‰. ☑

**READING CHECK**

**7. Define** What is salinity?

_____

_____

### MEASURING SALINITY

Modern instruments measure salinity by recording the conductivity of water. *Conductivity* is a measure of how easily electricity moves through water. Electricity moves more easily through water with high salinity. ☑

**READING CHECK**

**8. Describe** What is one way scientists measure salinity?

_____

_____

_____

## What Affects the Salinity of Ocean Water?

Precipitation and evaporation rates affect the salinity of water. Precipitation, such as rain and snow, is made of fresh water. When precipitation falls, the fresh water enters the ocean. However, evaporation removes water from the ocean. Dissolved salts and other solids do not evaporate with the water. They stay in the ocean. In some places, the evaporation rate is higher than the precipitation rate. This increases the salinity of the surface water. ☑

**READING CHECK**

**9. Summarize** How do evaporation rates affect salinity?

_____

_____

_____

_____

Tropical regions have the highest precipitation rates. For this reason, tropical ocean water has lower salinity than subtropical ocean water. Subtropical regions have the highest evaporation rates. Therefore, subtropical oceans and seas tend to have the highest salinities.

The salinity of most ocean water ranges from 33‰ to 36‰. The global ocean has an average salinity of 34.7‰. However, salinity can vary greatly. For example, the Red Sea has a salinity of 40‰. The high salinity is due to the hot, dry climate around the Red Sea. This climate causes high levels of evaporation.

**Math Skills**

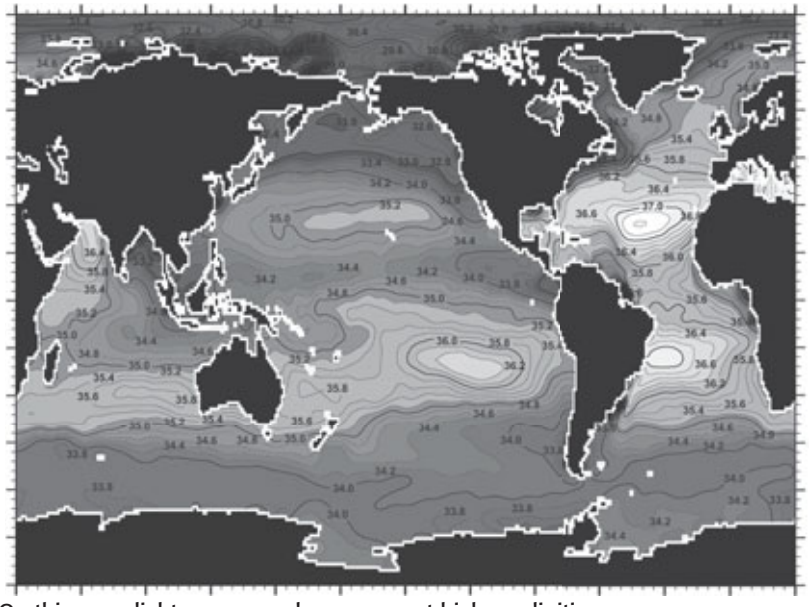
**10. Calculate** What is the range of salinity in ocean water? Express your answer using percentages.

_____

_____

_____

_____



On this map, lighter ocean colors represent higher salinities.

## LOOKING CLOSER

**11. Identify** Which ocean has a higher average salinity—the Pacific Ocean or the Atlantic Ocean?

_____

## What Affects the Temperature of Ocean Water?

Solar energy and water movement affect ocean temperatures. The depth and location of ocean water also affect temperature. Scientists mark layers of ocean water based on depth and temperature. These layers include surface water, the thermocline, and deep water. ☑

**READING CHECK**

**12. Identify** What factors affect ocean temperature?

_____

_____

_____

### SURFACE WATER

Waves and currents mix the water near the ocean's surface. This mixing action carries heat down to a depth of 100 m to 300 m. Therefore, the upper 100 m to 300 m of water has a fairly constant temperature. Temperature decreases only slightly as depth increases.

The temperature of surface water decreases as you move closer to the poles. The polar regions receive much less solar energy, or sunlight, than tropical regions do. As a result, polar surface water is much colder than tropical surface water. Tropical oceans can have a surface temperature of 30 ˚C. The surface temperature in polar oceans can drop to –1.9 ˚C.

## Talk About It

**Compare** With a partner, compare the surface water temperatures in different areas of the world. As you discuss, use phrases such as *cooler than* and *warmer than* to make comparisons.

Ocean water freezes at about –1.9 °C. As a result, large areas of sea ice form in polar oceans. A floating layer of sea ice that covers an area of the ocean surface is called **pack ice**. Pack ice can be up to 5 m thick. This layer of ice prevents the water underneath from freezing.

In the middle latitudes, the ocean surface temperature changes with the seasons. The ocean surface temperature may change by 10 °C to 20 °C between summer and winter.

The surface temperature of polar ocean water is below the freezing point of fresh water.

## LOOKING CLOSER

**13. Explain** Why does sea ice form in polar oceans?

_____

_____

_____

## THE THERMOCLINE

The thermocline is the layer of water under the surface layer. In the **thermocline**, the water temperature decreases sharply as depth increases. This decrease happens because the sun cannot directly heat ocean water below the surface layer.

The thermocline exists because the warm surface water cannot mix easily with the cold, dense water below. Thus, the thermocline separates the warm surface water and the cold deep water. The temperature of water below the thermocline decreases slowly. ☑

Changes in temperature or currents can affect the depth of the thermocline. These changes can even cause the thermocline to disappear. However, the thermocline is present under most of the ocean surface.

**READING CHECK**

**14. Summarize** Why does the thermocline form in ocean water?

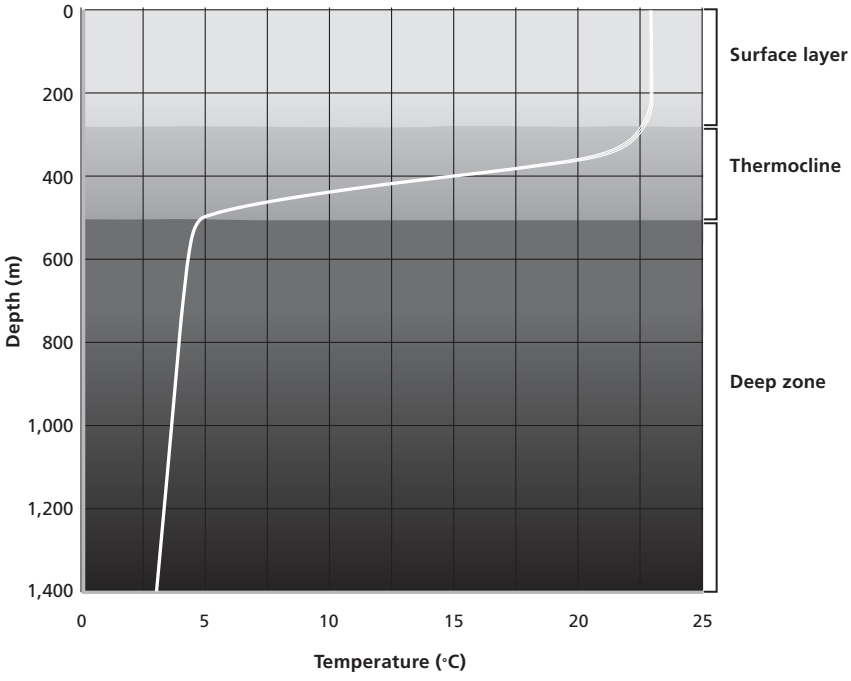
_____

_____

_____

## DEEP WATER

In the deep zones of the ocean, the water temperature is usually about 2 °C. The colder the water is, the denser it is. The density of cold, deep water controls the movement of deep ocean currents. This movement happens when the cold, dense water at the poles sinks. The water flows underneath warm water toward the equator.




The temperature of ocean water decreases as depth increases.

## LOOKING CLOSER

**15. Compare** In which zone does temperature decrease most slowly as depth increases?

_____

## What Affects the Density of Ocean Water?

**Density** is the amount of matter (mass) in a certain space (volume). For example, 1 g of pure water has a volume of 1 $cm^3$. Therefore, the density of water is 1 $g/cm^3$. Ocean water has a density between 1.020 $g/cm^3$ and 1.029 $g/cm^3$. Two main factors affect the density of ocean water: salinity and temperature. The table below summarizes the effects of these factors on density.

| Factor | How It Affects Density |
|---|---|
| Salinity | Dissolved solids add mass to water, but do not increase its volume very much. Therefore, as salinity increases, density increases. |
| Temperature | Cold water is denser than warm water. Therefore, as temperature decreases, density increases. |

Water temperature affects density more than salinity does. Therefore, the densest ocean water is in the polar regions. In these regions, the ocean surface is coldest. The cold, dense water sinks and moves through ocean basins near the ocean floor. ☑

## What Is the Color of Ocean Water?

The color of ocean water depends on the way water absorbs or reflects sunlight. The sun produces white light, which includes all the visible wavelengths, or colors, of light. Water absorbs the white light from the sun. Generally, the water reflects only the blue wavelengths. Therefore, ocean water appears blue.

### WHY OCEAN COLOR IS IMPORTANT

Substances or organisms in ocean water can affect the color of the water. For example, *phytoplankton* are tiny organisms in the ocean that carry out photosynthesis. Many other organisms eat phytoplankton. Phytoplankton absorb red and blue light, but reflect green light. Therefore, phytoplankton can affect the shade of blue of the ocean.

Scientists can study the color of the ocean to see if phytoplankton are present. Since phytoplankton need certain nutrients, these organisms can show scientists the health of the ocean. If the ocean color shows that no phytoplankton are present, the water may lack nutrients.

### LOOKING CLOSER

**16. Identify** What two factors affect the density of ocean water?

_____

_____

### READING CHECK

**17. Explain** Why does ocean water generally sink near the poles?

_____

_____

_____

_____

_____

_____

### Critical Thinking

**18. Identify Relationships** How would a decrease in phytoplankton affect other ocean organisms?

_____

_____

Name _____ Class _____ Date _____

# Section 1 Review

## SECTION VOCABULARY

**density** the ratio of the mass of a substance to the volume of the substance; commonly expressed as grams per cubic centimeter for solids and liquids and as grams per liter for gases

**pack ice** a floating layer of sea ice that completely covers an area of the ocean surface

**salinity** a measure of the amount of dissolved salts in a given amount of liquid

**thermocline** a layer in a body of water in which water temperature drops with increased depth faster than it does in other layers

**1. Explain** Why is ocean water denser than fresh water?

**2. Summarize** How does water temperature affect the ability of ocean water to dissolve gases?

**3. Describe** What is ocean water made up of?

**4. Explain** How does the density of ocean water control the movement of deep ocean currents?

**5. Explain** Why does ocean water appear to be blue?

**6. Analyze Processes** Suppose that global temperatures increase. How could this change affect the ability of the ocean to absorb $CO_2$? Explain your answer.