Fresh Water and Salt Water

If all the water on Earth were drinkable fresh water, it would be a very long time before we ran short of water (Figure 1). Unfortunately, most of the water is in the oceans, and it is salt water. Only 3% of Earth’s water is fresh water—not salty—and most of that is deep under the surface or frozen in glaciers and polar ice. Only 0.4% of Earth’s water is liquid fresh water at, or near, the surface. Even so, “fresh water” does not always mean “water suitable for drinking.”

Comparing Fresh Water and Salt Water

How are fresh water and salt water different? To begin to answer this question, consider the Dead Sea. Swimmers can float in the Dead Sea with little effort (Figure 2). This is because the Dead Sea has a very high salinity—it contains a lot of dissolved salt. **Salinity** refers to the amount of salt dissolved in water. Salinity is expressed either as a percentage or as a concentration in g/L. Remember that **concentration** is the amount of solute in a particular volume of solution. The Dead Sea is a 30% salt solution. Therefore, the concentration of salt in the Dead Sea is 300 g/L.

In comparison, the average salinity of the world’s oceans is only 3 to 4%. The salinity of any freshwater source (such as the Great Lakes) is less than 1%.

Salt water has a greater density than fresh water (Figure 3). Objects that are more dense than a liquid will sink in that liquid; objects that are less dense than a liquid will float in it. For example, the water in the Dead Sea contains so much salt that the water is much more dense than a human body. The high density of salt water allows swimmers to float easily on the surface.
Desalination
Is there a way to change salt water into fresh water? To answer this question, think about the changes of state that water undergoes as it moves in the water cycle.

**TRY THIS: What's Left Behind?**

SKILLS MENU: performing, observing

In this activity, you will compare what is left behind when a sample of salty water and a sample of tap water are left in open containers for several days.

**Equipment and Materials:** small graduated cylinder; 2 cups or small bowls; marker; teaspoon; warm tap water; 2 paper labels; salt

1. Measure 10 mL of warm tap water. Pour the water into one of the cups. Label the cup “tap water.”

2. Measure about half a teaspoon of salt into the graduated cylinder. Add warm tap water to the cylinder until the total volume of the solution is 10 mL. Swirl the salt-and-water mixture until the salt dissolves completely. Pour the salt solution into the second cup. Label this cup “salt water.”

3. Place the two cups in a warm place where they will be undisturbed for several days. Check on them periodically and record your observations.

A. What did you learn from your observations? Does salt evaporate along with water?

B. How could you use what you learned to change salt water into a source of drinking water?

The Try This activity shows us that only water evaporates from the oceans, leaving the solid salt behind. This is why rain is not salty!

There are many places on Earth that have plenty of salt water but not enough fresh water to meet people’s needs. Engineers have developed ways to separate fresh water from salt water to solve this problem. **Desalination** is any process that removes salt from water, producing pure water and solid salt.

Some desalination technologies involve evaporating and then condensing water to remove the salt. This process requires a lot of thermal energy, which makes it very expensive compared to using fresh surface water or groundwater directly. Some desalination technologies involve using renewable energy sources, such as energy from the Sun (Figure 4), or geothermal energy.

A recent advance in desalination technology uses osmosis across a membrane with tube-like pores called nanotubes. Water particles can easily pass through the little nanotubes, but salt particles and other large non-water particles cannot.

**CHECK YOUR LEARNING**

1. What percentage of water on Earth is fresh water?
2. Describe two special characteristics of salt water.
3. (a) Why are engineers developing desalination technologies?  
   (b) Briefly describe a desalination process.

4. (a) What can make desalination expensive?  
   (b) Name two renewable energy sources that can be used in desalination.