Grade 5 Science

Week of December 14 – December 18

Separating Solutions

Why We Separate Mixtures

Most of the substances we use every day are actually a part of a **mixture**. If we want to use an individual component of a **mixture** these parts must be separated from each other. Even in nature, most elements and compounds do not come in their pure form but in a mixture of different substances.

Example:

Common table salt is separated from sea water (sea salt) or mined (rock salt). Other elements are also removed from it so it is safe for human consumption.

Images adapted from National Geographic

Separating substances from mixtures is an important part of chemistry and important in our modern industries.

The way different mixtures are separated is called a **process**. There are many different **processes** used for separation. Many of the **processes** are very complicated and even dangerous, especially if they use hazardous chemicals or extreme temperatures.

For this section, we will focus on separation processes that will separate the components of a solution or separate the solute from the solvent.

Distillation

One process that can be used to separate homogenous mixtures or solutions is called **distillation**.

Distillation uses boiling to separate the components of a solution. **The boiling point is** the temperature at which a liquid will boil. For example, water boils at 100°C and olive oil boils at 300°C.

When the heated solution (a liquid solvent with dissolved solutes) reaches the boiling point of the liquid, the liquid will start to evaporate. The liquid will turn to vapour or gas (i.e., steam if it is water). The vapour travels up into a tube that cools it down and condenses it back into a liquid. You are left with the solute in the original flask, now in higher concentration since water has been removed, and pure water in the other container.

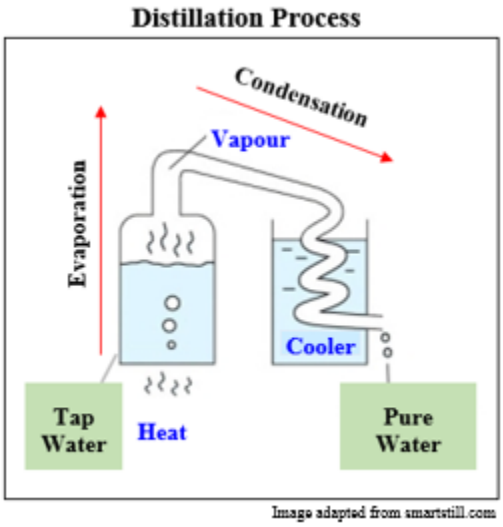


Image adapted from smartstill.com

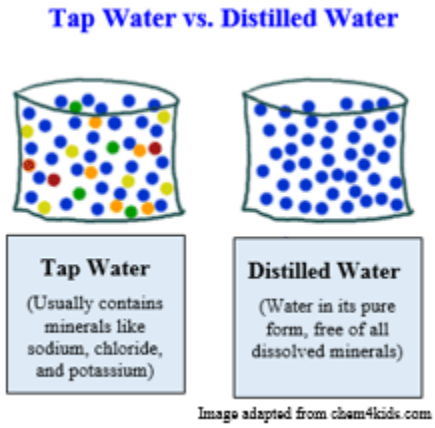
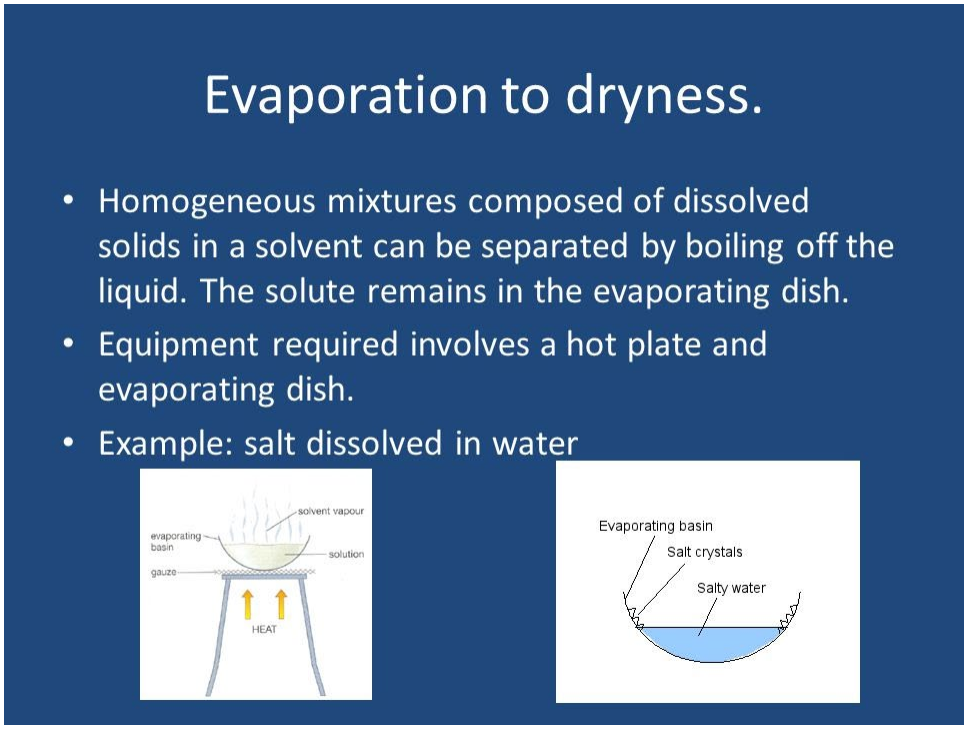


Image adapted from chem4kids.com

Evaporation to Dryness

We have all observed water evaporation occur when we put our clothes in the dryer or hang up a beach towel outside after going swimming. The evaporation of water (or sweat) from our skin when we exercise or when it's very hot outside keeps us cool. This cooling is because the **heat energy** from our skin is used to **change the phase of the water** from a **liquid to a gas.** The escaping water vapor takes the energy with it, leaving you with less heat and feeling cooler.

In high-school chemistry, you may use a Bunsen burner or hot plate and an evaporating dish to remove water from a solution so that the solid residue or solute, often a salt, can be separated from the solution. The image below shows this set-up and procedure.



Crystallization

Crystallization or crystal formation is another way that a solid solute can be separated from a solution.

Crystallization begins when molecules of the solute start to **clump** together into clusters in the solution. This clumping is called **nucleation**. After this clumping takes place, then more solute molecules start to attach to this nucleus in an ordered arrangement, one layer at a time, to form a crystal.

An example that you may have seen is liquid honey forming crystals and no longer pouring very well afterward. Sometimes these crystals take a very long time to form like in gemstones. Other crystals may form quickly like water crystals in snowflakes.

Another way to form crystals is to make a **supersaturated solution** and add **seed crystals** that other solute molecules will grow upon. To make a supersaturated solution you add more solute than can

normally be dissolved in the water and **heat it up**. Warming allows more of the crystals to dissolve. After the solution cools, you can add seed crystals of the same solute and crystals will start to grow. The video below shows how this can be done with table sugar or sucrose. Please do not try this at home as it can be very dangerous and requires adult supervision.

Sugar Crystal Procedure: https://youtu.be/8MmMi-W_dsw

The crystallization of copper (II) sulfate solution is shown in the video below. The dissolved $CuSO_4$, a blue crystalline solid, is separated from a solution by heating it to increase its solubility in water and then cooling it to crystallize the solid.

Crystallization: https://youtu.be/rF4scC54FfQ

Sea Salt Production

Salt is essential for the life of humans and other animals. We need salt to control our fluid balance and for our nerves and muscles to work properly. Today, salt is readily available and inexpensive to purchase but this was not always true. The economic trade of salt and the use of salt as currency (money) dates back thousands of years. If you were "worth your salt" it meant you earned the money you were paid or your "salary", another word that comes from salt. Famous cities like Salzburg (in Austria) grew around salt mines and trade routes or salt roads like the Salaria (in Italy) were developed to transport salt to places that needed to buy it. Before refrigeration, salt was important for food preservation.

Since prehistoric times, sea salt has been produced from sea water by evaporation of the water and drying of the solid residue or salt crystals. This practice continues around the world today. The video below shows how homemade sea salt is made on Canada's east coast.

Sea Salt Making Tutorial: https://youtu.be/YCpdgxxkRkY

Separating Solutions

1. Using the terms solvent and solute, explain how distillation works?

2. What equipment is needed to evaporate a solution to dryness? How does the process work?

3. List two ways that crystals can form in a solution.

4. If you brought a container of clean seawater home with you, how could you prepare your own sea salt?

5. If you want to separate the liquid solvent from a solution and keep it what separation method can you use?

6. If you want to separate the liquid solvent from a solution and not keep it what separation method can you use?

7. Given two unlabelled jars of water how could you determine which one is from Okanagan Lake and which one is from the Pacific Ocean?

8. If given the three different solutions that are described below how could you identify each one using separation techniques? No tasting allowed as it is never a safe procedure with unknown liquids.

    a. Salt dissolved in water.

    b. Carbonic acid dissolved in water.

    c. Alcohol dissolved in water.