Separating Mixtures
Junior Science
A solution is made up of a solvent and a solute. A solvent is a substance such as water that is able to dissolve a solute. The solvent ‘pulls apart’ the bonds that hold the solute particles together and the solute particles diffuse (spread randomly by hitting into each other) throughout the solvent to create a solution. The solution is a mixture with evenly spread solvent and solute particles. These particles can be physically separated by evaporation.
Where has the sugar gone?

When a solid mixes into a liquid and can no longer be seen it has **dissolved**. Often the particles of the solute seemed to have disappeared but they are all still present. They are now just in very small particles, too small to be seen by eye.
Solutions are simply **mixtures** of materials, one of which is a liquid or a gas. The liquid or gas, also called a fluid because it is able to flow. One of the most common solvents is water. All water found in natural sources on Earth, except in rain water or ice, is in the form of a solution – such as **salt water** in the oceans and **mineral water** in rivers, springs, water and lakes. Minerals from the surrounding rocks are eroded and dissolved into the water.
Both dissolving and melting are physical changes but they involve different processes.

**Dissolving** and **melting**

- **MELTING**: All solids will melt into liquids if you apply enough **heat energy**.
  - Heating adds more kinetic energy to particles.
  - Particles will break free from each other to form a liquid.

- **DISSOLVING**: Some solids will dissolve into solvents to form a **solution**, which is a mixture.
  - The solid sugar cubes are added to a cup of coffee (a mixture of water and coffee granules).
  - The coffee dissolves the sugar and the particles are spread throughout the solution.
Many drinks we purchase are solutions. Most of them are solutions of mainly sugar (solute) and water (solvent) with a small amount of flavouring, colouring and some minerals mixed in. We do not “see” the sugar because it is dissolved into the water and becomes too small to see. This means a lot of sugar can be hidden in the liquid and we are unaware of the amount of sugar we take in, even in so-called healthy sports drinks.
Saturated solutions

The amount of a solid (solute) that can be dissolved into a solvent to form a solution depends on the solubility of the substance. When a solvent can dissolve no more solute then the solution is known as saturated. If any more solute is added after this point then solids crystals begin to form.

<table>
<thead>
<tr>
<th>Unsaturated solution</th>
<th>Saturated solution</th>
<th>Supersaturated solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>more solute dissolves</td>
<td>No more solute dissolves</td>
<td>Becomes unstable, crystals form</td>
</tr>
</tbody>
</table>

Increasing concentration
A solution becomes more **concentrated** as more solute is dissolved into the solvent. When a solvent can dissolve no more solute – and extra solute added remains as a solid – the solution is said to be **saturated**.

To **dilute** a solution more solvent is added – so there becomes fewer particles of solute dissolved into the solvent as a solution becomes more **diluted**.
Mixtures can be separated by physical processes.

Mixtures of substances are not chemically bonded (joined) to each other so they can be separated by physical techniques.

The state of the various substances in the mixture, such as a liquid and solid or the physical properties of the substances, such as different boiling points will determine which method of separation will be used.
Mixtures are made up of different components. Components of air mixture

Mixtures can be physically separated into different components. A common household example of a mixture could be a cup of white coffee. This mixture is made up of three major components: Milk, coffee and water. Milk itself is a mixture that can be further broken down into other components such as fat, protein, sugar and water.
Science labs contain equipment that are used to carry out separation of mixtures. You will need to remember the name and how to draw this equipment, using common equipment diagrams.
In the science lab we often have to draw the equipment. We use diagrams to show the equipment, which saves us time drawing. The scientific diagrams are recognised world wide.
Mixtures can be easily separated physically using methods such as: Filtering

Filtering separates an **insoluble solid** in a mixture from the **liquid** completely. The solvent molecules (liquid) and any dissolved molecules present in the solution can pass through the filter paper, which has small holes, while the solid particles cannot because they are too large and stay in the filter paper. The solvent or solution containing dissolved substances passes through the filter paper, is called **filtrate**. The solid particles that remain on the filter paper are called the **residue**.
When two solid substances are mixed together they can be separated by **dissolving**. A solvent such as water can be added if only one of the substances is soluble. For example; if salt is mixed with dirt then adding water will dissolve the salt (which can later be separated by evaporation) and the remaining dirt can be removed from the solution by filtering. The salt becomes the solute and will go through the filter as it is in solution.
Mixtures can be easily separated physically using methods such as: Evaporating (by boiling)

Evaporating separates a dissolved solid from a liquid. The solvent (liquid) is lost into the surroundings.

The liquid will evaporate but evaporation becomes faster at higher temperatures.

The solid remains because it has a higher (often very much higher) boiling point than the liquid.
Mixtures can be easily separated physically using methods such as: Decanting

Decanting is simply pouring off a liquid without losing any of the more dense substance (usually an **insoluble solid**) in the bottom of the container. Decanting separates a **heavier substance from a lighter one**. Chemists are most often after the substance at the BOTTOM of the container.

Original mixture of a solid and liquid

Heavier solid is allowed to settle to the bottom

The liquid is poured off the top while the solid remains
Mixtures can be easily separated physically using methods such as: Magnetism

Magnetism can be used to separate a magnetic substance (such as iron) from a mixture containing non-magnetic substances (such as sulfur or sand).

The magnetic substance of the mixture is separated with the help of the magnetic attraction. A magnet is moved over the mixture containing the magnetic substance e.g., iron filings. These get attracted to the magnet. The process is repeated until the magnetic material is completely separated from the mixture. The non-magnetic substance is left behind.
Mixtures can be easily separated physically using methods such as: Chromatography

Chromatography is a method used to separate the various substances in a **mixture of dye or ink**. Substances of the mixture will differ in how much they "stick" to things: to each other, and to other substances. Some of the substances of the ink will stick more tightly to the paper fibres. They will spend less time in the water as it moves along the paper fibres, and they will not travel very far. Other components of the ink will stick less tightly to the paper fibres. They will spend more time in the water as it moves along the paper fibres, and they will travel further through the paper.
Distillation is a process of boiling a liquid until it forms a vapour and condensing, then collecting the liquid. The liquid collected is the distillate. The Liebig Condenser cools the vapour back into liquid. The purpose of distillation is separation of a mixture of two liquids. This is possible if the two substances have different boiling points. The substance with the lower boiling point turns to gas and is collected while the other substance with a higher boiling point remains as a liquid in the flask.
<table>
<thead>
<tr>
<th>Separation technique</th>
<th>Property used for separation</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Attraction</td>
<td>magnestism</td>
<td>magnetic iron can be separated from non-magnetic sulfur using a magnet</td>
</tr>
<tr>
<td>Decanting</td>
<td>density or solubility</td>
<td>liquid water can be poured off (decanted) insoluble sand sediment less dense oil can be poured off (decanted) more dense water</td>
</tr>
<tr>
<td>Filtration</td>
<td>solubility, size of particles</td>
<td>sand can be separated from a solution of sodium chloride in water by filtration</td>
</tr>
<tr>
<td>Evaporation</td>
<td>solubility and boiling point</td>
<td>soluble sodium chloride can be separated from water by evaporation</td>
</tr>
<tr>
<td>dissolving</td>
<td>solubility</td>
<td>soluble salt can be separated from sand by dissolving into a solvent</td>
</tr>
<tr>
<td>Distillation</td>
<td>boiling point</td>
<td>ethanol can be separated from water by distillation because ethanol has a lower boiling point than water</td>
</tr>
</tbody>
</table>
Separation processes can create substances that are useful for us.

In areas that have a limited amount of fresh water but access to salty sea water, a purification machine (as shown to the right) can be used to separate out the salt and other substances from the pure water that can then be drunk.

If we require the salt instead of the water, we use the same starting solution of salt water. This time we evaporate off the water in large holding ponds and collect the salt deposits that remain.
Survival with a solar sill – making pure water from salty water

With a few pieces of equipment a **solar sill** can be made to produce clean drinking water. A **hole** must be dug with a container of the salty water placed at the bottom. Another **collecting container** sits on top with a straw leading out of it for drinking. A **plastic sheet** covers the hole and is secured with rocks. A rock weight is placed on the sheet. Water is **evapourated** from the salty water, **condenses** on the plastic sheet and drips into the collecting container.