

## Background information

### Year 7, unit 1: Mixing and separating

#### Mixtures

When two or more kinds of matter are put together a mixture is formed. The process of being mixed does not change the components of a mixture and they retain their individual properties.

Mixtures are combinations of substances that are not combined chemically. The amounts of substances in a mixture can vary. Students should understand that mixtures can change in appearance but this does not mean that the chemical composition of any of the substances has changed. Most substances found in nature are mixtures.

Mixtures can occur in any of the four phases of matter or they can be in combinations of different phases. Air is a mixture of gases, milk is a mixture of solids and liquids, alloys are mixtures of solids.

The combinations of substances in a mixture give it properties that are different to those of the original substances. Each component has a particular purpose. For example, in sherbet the sugar and jelly crystals add sweetness and flavour while the acids and bicarbonate soda react with saliva to produce carbon dioxide that gives the fizziness. In a bubble mixture of detergent, water and glycerine, the detergent makes the film that the water particles stick to and the glycerine strengthens the bubbles.

Varying the amounts of the different components will change the properties of a mixture. For example, adding more sugar to a cup of tea will make it sweeter, adding more pigment to a paint will make the colour darker, adding water to paint will make it runny and easier to spread but may decrease depth of coverage.

#### Types of mixtures

Mixtures can broadly be divided into two categories – heterogeneous mixtures and homogeneous mixtures.

Heterogeneous mixtures are ones in which the individual components are not mixed evenly throughout the mixture. Homogeneous mixtures are more easily distinguished, as the different components are more easily seen. Examples of heterogeneous mixtures include oil and water, sand and water, muesli and chocolate chip cookies.

Homogeneous mixtures are ones in which the different components are evenly mixed and these mixtures look the same throughout. All solutions are classified as homogeneous mixtures. Examples of homogeneous mixtures are salt water, clean air and skim milk.

#### Solutions

Solutions have only one phase and the most common solutions are liquids, although there can be solutions of gases (air) and solids (alloys).



In a solution the substance that is dissolved is the solute. The liquid that does the dissolving is the solvent. Water is a common solvent.

## Separating mixtures

Sometimes mixtures need to be separated back into the substances that were originally mixed together because one or more of these substances may be particularly valuable or useful.

For example:

- wheat is separated from chaff to obtain the seeds
- salt is separated from salt water
- gold panning separates particles of gold from dirt, sand and rocks
- fresh water is obtained from dirty water or sea water.

When mixtures are separated the technique used is based on the physical properties of the substances that make up the mixture. The original substances are retrieved unchanged. Salt and water are mixed to produce salt water and the salt can be retrieved by evaporating the water. The salt retrieved is the same as the salt which was dissolved.

Mixtures may also need to be separated for other purposes. Processes like drug testing at the Olympics can measure trace amounts of banned substances in an athlete's blood. Foods are regularly tested for levels of a variety of different substances to make sure the manufacturer's claims are true and in order to protect our health. Rubbish can be separated into recyclable material, composting material and material for dumping. This process is good for the environment because it reduces the amount of material going into landfill.

There are many different techniques for separating mixtures. These include:

- handpicking
- threshing
- winnowing
- jigging and panning
- filtering (or sieving or straining)
- evaporating or boiling
- freezing
- chromatography.

Each of these techniques relies on differences in properties between mixtures and each of the components in the mixture.

## Handpicking

This is a basic method of separating substances. It involves picking out substances by hand and separating them from others. It is a manual process and used when the components of the mixture to be separated are large and easily distinguished. Removing almonds from a nut mixture, collecting shells on the beach or separating recyclable plastics from a mixture of plastics, all involve handpicking.

## Threshing

Threshing is the process of separating grain from the stalk. It involves beating the dry stalks to shake off the dried grains. Traditionally, threshing was done by hand, however today threshing machines are used to separate large quantities quickly.

## Winnowing

This technique is often carried out following threshing. Although the grains have been separated from the stalks they still have dried husks and chaff that have to be removed before the grains can be used. Winnowing is the separation of the heavier particles (grains) from the lighter husk and chaff using wind or moving air. The mixture, held in a basket, is thrown up in the air, wind blows the lighter particles away and the heavier grains are caught again in the basket. This process needs to be repeated several times to achieve good separation.

Handpicking, threshing and winnowing have been used for centuries by ancient cultures such as Indigenous Australians, the Greeks, Indians, Chinese and Egyptian. These techniques are still used by a variety of peoples today.

## Jigging and panning

Jigging is one of the oldest processes used to separate heavy minerals as well as gold and gemstones from lighter soils and pebbles. It can be done by both hand and by mechanical processes. Both processes rely on differences in density of the materials to be separated.

In this process the mixture is added to a bucket of water that is then plunged up and down in a tub or under a stream flowing water. The force of the water separates the light and heavy fragments. The lighter fragments rise to the surface and are washed away while the heavier ones sink to the bottom.

Panning is a simpler process in which the rock or soil mixture is placed in a shallow tray and then swirled in water. The lighter material floats away and the heavier particles remain in the tray.

## Filtering, sieving and straining

These separation techniques rely on the differences in size of the particles of the substances that make up the mixture. The effectiveness of separating a mixture by filtering (or sieving or straining) depends on the size of the holes in the filter (or sieve or strainer) compared to the size of the particles being separated. The important thing to remember is that the holes in the filter must be smaller in size than the particles of the solid substance being separated.

The term 'filtering' is generally used when the mixture contains a solid and a liquid, for example sand and water. When a sieve is used, the process is usually referred to as sieving. For example, a mixture of sand and gravel is separated using a sieve and works because the gravel particles are much larger than the sand particles. When a strainer is used the process is referred to as straining. For example, straining the spaghetti from the water after cooking.

There are many practical examples of separating mixtures by filtration. Some include:

- using a tea strainer or tea bag
- the filter in vacuum cleaner allows the air to pass through but not the dust and other substances
- using a coffee filter
- sieving flour to remove any lumps.

## Evaporation or boiling

This technique is used when a dissolved component needs to be recovered from a solution. For example, salt is extracted from seawater by evaporating the water. Evaporation relies on the different substances in a mixture having different boiling points. The mixture can be left out in the open (or put in an oven or on a hot plate) and the component with the lowest boiling point will evaporate leaving the other substance (or substances) behind.

## Freezing

This technique can be used to separate two liquids when they have different freezing points. For example, a mixture of oil and water can be separated by placing it in the freezer. The water will freeze but the oil will not. The ice can be removed leaving the oil behind.

## Chromatography

Chromatography is a very useful method for separating mixtures. Scientists use different forms of chromatography to separate mixtures and identify the components of the mixture. It is an especially useful technique when there is only a small amount of the mixture available and is quite a quick procedure. Medical scientists can identify some diseases by studying blood and urine chromatography. Forensic scientists use chromatography to match pen and ink samples in cases of suspected forgery. They also use this technique to compare dyes in fabric or fibre samples left at the scene of a crime with those found on a suspect.

Different dyes are made of different chemicals. These chemicals have different solubilities in water. As the water moves up the filter paper the more soluble dye will be carried along with the water while dyes that have lower solubility will tend to move more slowly. A mixture of dyes will therefore separate out into its pure components.

## Applications of separation techniques

### Everyday applications for separation techniques in the home

#### Evaporation

- Clothes drying in the dryer or on the washing line.
- Evaporating water to retrieve salt or sugar.

#### Filtering

- Using a jug with a filter so water from the tap can be filtered for drinking.
- Using a coffee filter for filtering coffee.
- Using a tea strainer or tea bag.
- Filters in pools, air conditioners, vacuum cleaners and car engines.

## Sieving in cooking

- Removing rice or pasta from cooking water.
- Sifting flour or other ingredients.
- Separating an egg.
- Washing lettuce in a salad spinner.

## Other separation techniques not seen in the home

### Distilling

- Distillation of alcohol.
- Distillation of essential oils from plants.
- Distillation of crude oil to obtain fuels for vehicles.
- Distilling salt water to produce fresh water.

### Evaporating

- Obtaining salt from salt water.
- Producing a thin metal layer on plastic film.
- Producing dried foods (eg instant coffee, dried peas and beans, dried fruit).
- Producing dried versions of antibiotics and vaccines so they last longer and don't need refrigeration.

### Filtering

- Removing solids from water.
- Sewerage treatment.
- Filtering blood to separate cells and plasma.

## Familiar professions that use separation techniques

- Chemists – decanting, filtering, distilling, chromatography.
  - Pharmacists – decanting, filtering.
  - Chefs – decanting, sieving, filtering.
  - Dentists – safe disposal of mercury fillings (filtering).
  - Miners – jigging and panning, hand picking.
  - Archaeologists and geologists – sieving, sifting, hand picking.
  - Doctors – chromatography for blood processing, filtering blood, testing blood.
  - Farmers – winnowing, threshing, filtering, decanting.
  - Industries such as water treatment plants, sugar mills, factories, and refineries.
- Processing plants also use a range of separation techniques.

## Lesson 1: making sherbet

In this activity students investigate how changing the proportions of the components of a mixture changes the properties of the mixture. As the students will taste the ingredients, ensure all equipment is clean. Dispose of used sandwich bags, paddle pop sticks etc.

**Safety advice:** This activity should not be performed in a science laboratory as there could be contamination of the ingredients being ingested.

## Materials (for a class of 25)

- 2 paddle pop sticks per student (1 scoop = 1 paddle pop stick)
- 100 g icing sugar
- 2 packets jelly crystals
- 20 g citric acid
- 20 g tartaric acid
- 20 g bicarbonate soda
- 3 sandwich bags/student

## Procedure

1. Make students wash their hands before they start. Emphasise hygiene in this activity.
2. Place a scoop of each ingredient **in the following order** on the palm of each student's hand. Students record the taste of each sample in the table provided. Don't identify the name of the ingredients
  - A. icing sugar
  - B. jelly crystals
  - C. citric acid
  - D. tartaric acid
  - E. bicarbonate soda
3. Each student follows the standard recipe by collecting ingredients in a sandwich bag from the stations previously set up by the teacher.
4. Students taste their sherbet and decide which ingredient they would like to change. They have three opportunities to change the taste of their sherbet by changing one ingredient at a time. Remind students to label their bags.
5. Students select their most successful recipe to take home.

## Discussion

1. Identify the ingredients that tasted good and those that didn't taste good.
2. Discuss why the ingredients that didn't taste good were in the sherbet.
3. Compare recipes and highlight the fact that while the ingredients are the same, the taste and fizzing effect of these is dependent on the proportions.
4. Ask the students to write a conclusion relating the proportion of the components of a mixture to its properties.

## Lesson 2: separating a mixture of beans, rice and flour

Prior to the lesson make up a mixture of dried beans, uncooked rice and plain flour. Place a small quantity of the mixture in plastic cups – enough for one cup per group.

## Suggested equipment

- protective clothing, to prevent flour going all over students' clothes
- large plastic dinner plates or large aluminium pie trays (at least 2 per group)
- 2 plastic cups (per group) for collecting separated components
- sieves (preferable one per group but these can be shared). If there aren't enough sieves available, students could construct their own by putting small holes in a piece of plastic wrap and pouring the mixture into this

- newspaper, for easier clean up or to catch the flour if they choose winnowing

### **Possible procedure**

1. Pour the mixture onto a plate and use handpicking to remove the beans.
2. Place the separated beans in a cup.
3. Pour the rice and flour mixture into a sieve. Hold over a plate and shake to separate the flour (winnowing).
4. Place the separated rice and flour in different cups.