Separating mixtures

Warning – Aboriginal and Torres Strait Islander teachers and students are advised that this curriculum resource may contain images, voices or names of deceased people.

Glossary

alluvium: a large geological area of dirt, sand or gravel that has been deposited by running water, such as a stream or floodplain.

ancient: very old, from the distant past, especially before the end of the Western Roman Empire, AD 476.

chaff: the unwanted material, including the protective covering of seed that is separated from a seed in the process of 'winnowing' or 'yandying'.

cold-pressing: a separation technique that uses pressure to extract oils from plant matter.

colonisation: the act of one country invading and taking over another. The British began the colonisation of Australia in 1788.

compound: atoms from two or more elements that are chemically bonded together (into molecules) and can only be separated by chemical processes.

condensed: the finished process of water vapor in the air having been changed into liquid water.

control: a standard to which comparisons are made in an experiment.

coolamon: a multi-purpose canoe-shaped wooden dish with curved edges, used by First Nations Peoples in Australia.

density: a measure of the amount of matter that's contained within a space. Denser substances have more matter in a certain volume than less dense ones.

Dreaming stories: sacred Indigenous stories that teach about Creation, the land and rules for living.

element: a fundamental substance (atoms) that cannot be separated into simpler substances.

empirical: derived from or guided by experience or experiment.

filtering: to push a mixture through something with small holes in order to separate larger particles from smaller ones.

First Nations Peoples: Aboriginal and Torres Strait Islander People.

hypothesis: an educated prediction or guess about what might occur during a scientific experiment.

kangaroo apples: the fruit of either of two Australian native plants, Solanum aviculare and S. laciniatum, which are edible when completely ripe, but contain the toxic alkaloid solanine when immature.

matter: the substances the universe is made from. Everything that has mass and takes up space is made from matter.

mixture: two or more pure substances that are physically combined but can be separated back into their original forms.

poultice: a soft, moist mixture of plant material that is applied to the skin to treat a wound or reduce inflammation.

pure substance: matter containing only one type of atoms or molecules evenly spread through.

vaporised: when a liquid has changed state to become a vapour or gas.

verified: to confirm the truth or correctness of an experiment, by examination, repetition or comparison.

winnowing: a process that involves blowing air through grain to separate the heavier seed from the lighter chaff (the protective casing of the seed).

yandying: a way to separate grains of different sizes and densities by gently shaking them on an angle in a dish (e.g. a *coolamon*).

Separating mixtures

If you've ever baked a classic Australian pavlova from scratch, you may have felt like you were performing a kind of science experiment. The main ingredient of pavlova is egg whites, so the first step in the recipe is to separate the egg whites from the yolks of the eggs. There are many ways to do this. What methods do you know?

There are numerous materials that are useful to humans that don't exist naturally on their own. They're often found mixed up with other materials; for example, like how an egg white comes packaged with an egg yolk inside the shell of a chicken egg. To deal with this, humans have developed different ways to separate materials from mixtures. Some techniques you may have experience with include panning for gold, hand-picking shells from sand on the beach, or using a colander to separate boiled rice from water.

Understanding and classifying matter

There are some terms you may not have come across before beginning this learning, including **matter**, **element** and **compound**. To understand how different separation techniques work, and how the particles in a **pure substance** and a mixture can be modelled, it's important to understand the terminology and how scientists classify matter into the following hierarchy:

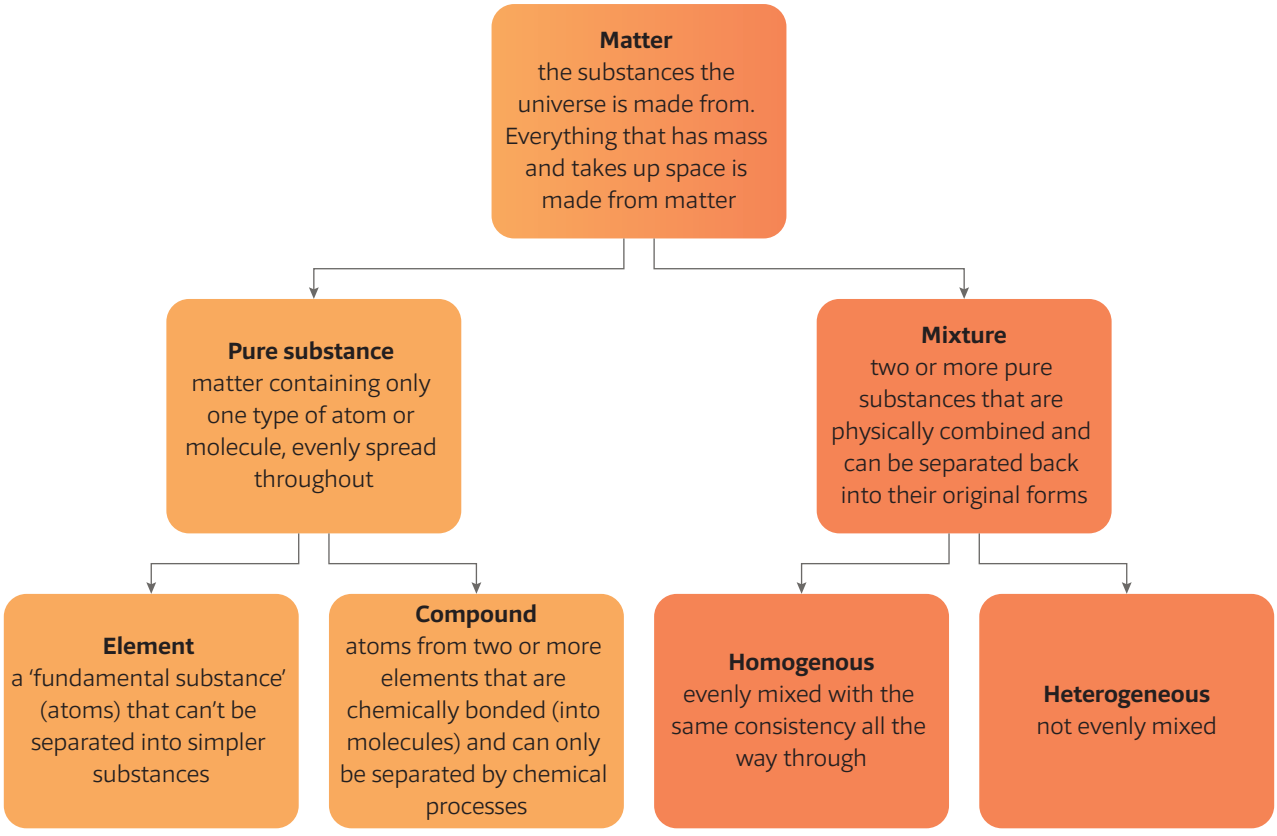

Figure 1: Relationships between the types of matter and the methods used to separate mixtures.

Indigenous chemistry

Chemistry is an **ancient** practice that people around the world have been experimenting with for thousands of years. Separation techniques that can be done by hand (without machines) are essential for survival: for creating medicines, preparing food and purifying water.

First Nations Peoples use various separation techniques to isolate and extract substances within mixtures, including hand-picking, **winnowing**, **yandying**, sieving, **filtering**, **cold-pressing** and steam distillation (ACARA 2021).

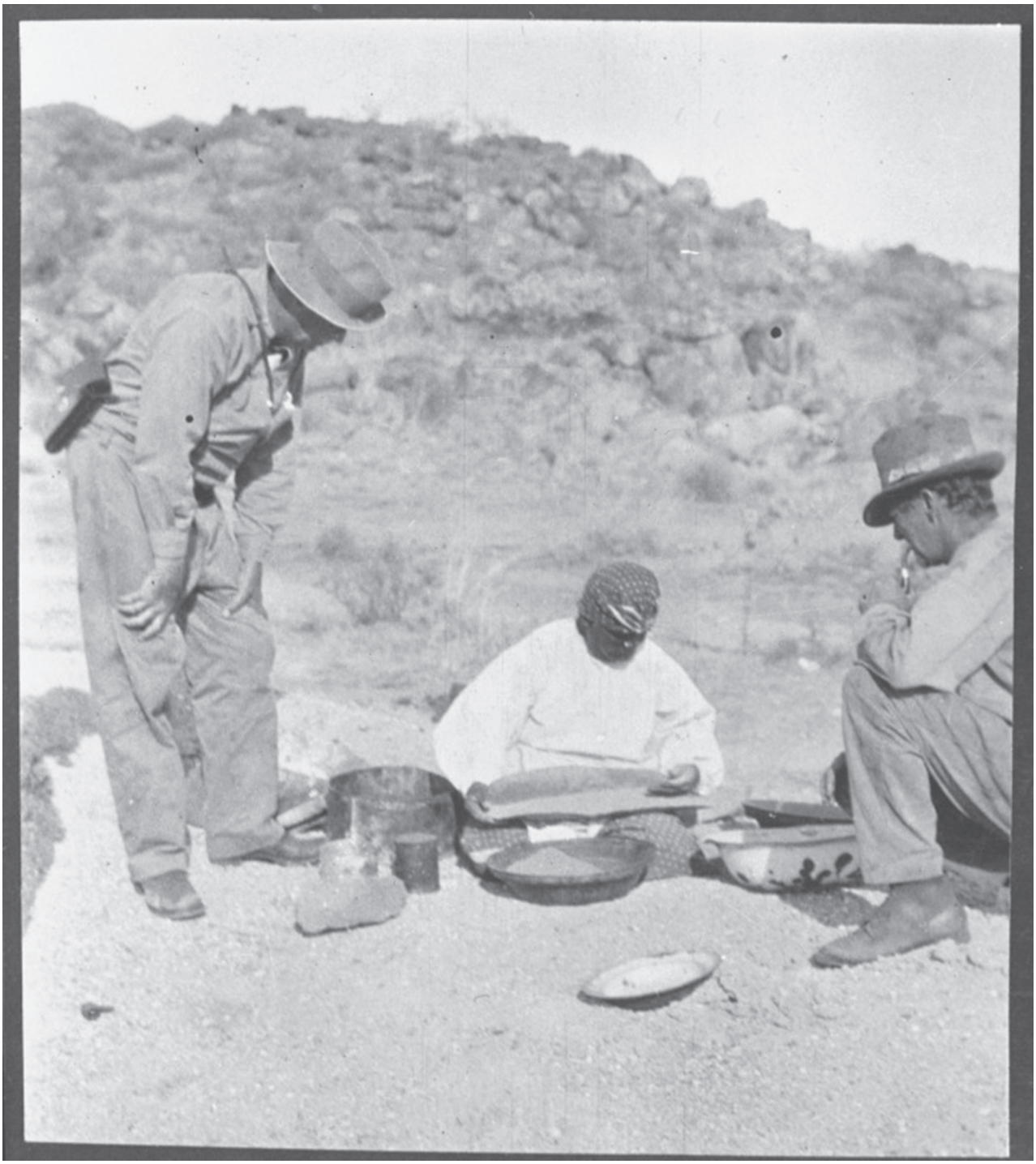

Figure 2: A woman winnowing.

Source: (c. 1900) *Aboriginal woman winnowing, watched by two men, North-West Australia* [photograph], State Library of Western Australia, <055553PD> . Reproduced with permission.

Winnowing

Winnowing is an ancient separation technique used across many cultures, including First Nations Peoples (*see* Figure 2).

Its purpose is to separate seeds from other unwanted parts of a plant that aren't good for eating (known as **chaff**). First Nations people of Kiwirrkurra community in the Gibson Desert harvest the seeds of the thick-leaved mallee tree (*Eucalyptus pachyphylla*) to grind, and then combine with water to eat as a paste. To harvest the seed, hand-pick unopened gumnuts are dried in the sun until they open. Sometimes tree branches are carefully burnt to trigger the opening of the gumnuts. The cooled branches are then tapped on the edges of large wooden dishes (**coolamon** or *piti*) to release the seeds. The seeds are then separated from any grit and chaff from the tree by winnowing in the wind using a large wooden dish (Nangala et al. 2019).

Cold-pressing

Cold-pressing is a separation technique that uses pressure to extract oils from plant matter. No heat is used in the process. First Nations Peoples cold-press macadamias and coconuts for their oil by grinding the plant matter to a pulp and extracting the liquid content by applying pressure to the pulp mixture (ACARA 2021).

Essential oils from medicinal plants are widely used for their healing properties. The oil from the narrow-leaved poverty bush (*Eremophila alternifolia*) is used as a rubbing medicine and **poultice** by First Nations Peoples between the far west of New South Wales, the far south of Northern Territory and the southern half of Western Australia. The oil is extracted by finely chopping the leaves and mashing them, using pressure, into an oily paste that can then be applied directly to the skin (ACARA 2021).

Filtering

If you've ever used a colander to separate pasta or rice from water, then you've used a type of filter. The basic principle of filtering in chemistry involves pushing a mixture through a physical barrier with small holes or gaps to separate the larger particles from the smaller ones. We often think of filtering when it comes to maintaining and cleaning our drinking water.

Living on the driest inhabited continent in the world, First Nations people developed extensive knowledge of the groundwater systems of this land in order to survive. Water has been channelled, covered and filtered and managed sustainably for thousands of years, with this knowledge being passed down in **Dreaming stories**, such as the Rainbow Serpent (Skatssoon 2006).

A natural source of filtered water comes from wetlands. The plants within wetlands act like a filter by slowing down moving water, allowing large particles of sediment to settle on the stream bed.

The effect of colonisation

Before Europeans arrived, First Nations Peoples occupied every part of this continent we now call Australia, farming and looking after Country (Dorey 2021). European **colonisation** had devastating impacts on First Nations communities and cultures, and on the environment. First Nations Peoples were displaced from ancestral lands and were unable to care for Country (Victorian Public Sector Commission 2021).

Europeans looked for opportunities to exploit the land for resources wherever they could. Kuku-Nyungkul People, on the Upper Annan River region of the south-eastern Cape York Peninsula, lived upon large **alluvium** beds with tin deposits, which were mined by the Europeans. Tin mining requires the use of a continuous water supply to extract it, so local waterways were utilised resulting in devasting ecological impacts (Anderson 1983).

Whole creeks were diverted into dams, and the water in the surrounding creeks was made cloudy from mud. This left almost no clean water for Kuku-Nyungkul People to drink, bathe in or cook with. Spearfishing and diving for eels became difficult. Almost all culturally significant sites of Kuku-Nyungkul People are associated with waterfalls or waterholes, which were left heavily damaged or destroyed because of the mining (Anderson 1983).

In the face of adversity

Today, First Nations cultures continue to be shared and practised, despite the destruction caused by colonisation. In the face of the challenges presented by colonisation, First Nations Peoples fought to protect and practise cultures, and to integrate and adapt to new experiences in ways that are culturally appropriate and acceptable.

A good example of this is how Kuku-Nyungkul People adapted their skills to mine tin. This occurred from 1885 until about 1940. Some were so successful that they owned and operated their own tin mines, allowing them to generate an income when there were few other jobs available (Anderson 1983).

Yandying for tin

Like winnowing, yandying is a process that uses the property of **density**. But instead of using the wind to separate substances of different densities, this process uses gravity and vibration. A mixture is placed inside a wooden container (like a *coolamon*), raised slightly at one end, and gently shaken. This allows the larger and less dense particles in the mixture to stay at the top of the container and separate from the smaller and denser ones, which fall quickly to the bottom. It's called 'yandying' because Yindjibarndi People of the Pilbara region in Western Australia use the term 'yandy' to describe both the process and the wooden container that's used (ACARA 2021).

Yandying is often used to separate seeds from their pods, or from sand, dirt or ash. However, the woman in Figure 3 is yandying *tin* that has been mined, and separating it from dirt and other unwanted particles.

Figure 3: A woman yandying tin.

Source: Ernestine Hill (1932) *Woman Yandying Tin, While Other Women and Children Look on, Western Australia, c1932 to 1934* [photograph], The University of Queensland Australia Fryer Library website. Reproduced with permission.

Separation techniques today

Today, people from all cultures use a wide range of separation techniques to isolate substances within mixtures. The origins of some techniques are **ancient** and haven't changed in thousands of years, but others have evolved over time to incorporate machines and other technologies to aid the process. This is especially the case for industrial food processing, where large quantities of food are processed and separated.

Distillation

Different types of liquids have different boiling points. This means when you heat them, the temperature at which they boil, varies. For example, water boils when it reaches 100°C, but linseed oil boils at the much higher temperature of 287°C (Engineering ToolBox 2003). Distillation is a process that uses the different boiling points of liquids to separate them. It requires a complicated set-u0 of glassware in a laboratory to ensure the liquid that changes state, into a gas, can be **condensed** again back into a liquid in a new container.

Steam distillation

Steam distillation is the most widely used method to extract essential oils from plants today. The basic principle is that steam is pushed directly through the plant matter that contains the essential oils. The oils become **vaporised** in the steam and can be extracted once the water has been condensed in a separate container.

Eucalyptus and tea tree oils have been used for medicinal purposes by First Nations Peoples for thousands of years using the same basic principle. Fresh, wet, plant matter is steamed over small fires, vaporising the oils from the plant in the process (ACARA 2021). The steam is directly inhaled to relieve symptoms.

The global eucalyptus oil market's projected to reach a worth of AUD$630 million by 2026 (The Express Wire 2021). Australia's commercial eucalyptus oil production began in 1860 (The Downunder Blog 2020) and wouldn't have existed without the knowledges of First Nations Peoples. A point of contention is that the large profits of this industry, among other industries that have relied on Indigenous knowledges, aren't shared with First Nations Peoples who originally developed this science and technology – this is known as 'biopiracy' (O'Bryan 2004).

Why are First Nations Peoples' ideas and perspectives important in science?

When Joe Sambono, an Aboriginal science educator and Jingili man, was a student, he learnt that "Aboriginal people were nomads, hunters and gatherers, and otherwise didn't achieve much of interest in '40 000 years'" (Sambono 2018, para. 14). He explains, "when Western scientists first came to Australia, their 'best science of the day' was hugely shaped by racist attitudes and assumptions that have long since been abandoned by all but a few" (Sambono 2018, para. 31).

This meant that the scientific knowledges First Nations Peoples possess were overlooked at the time. These early racist attitudes have taken a long time to break down, to the point where we're only now starting to recognise how complex and important First Nations Peoples' discoveries are. As an Aboriginal science educator, Joe is challenging these views by demonstrating the many exciting discoveries First Nations Peoples have contributed to a collective understanding of science.

Missed opportunities in chemistry

Many Indigenous food and medicinal technologies have historically been ignored in this land we call Australia. This has resulted in missed opportunities as many of these technologies are now being exploited by overseas nations. For example, most of the world's medicinal eucalyptus oil and **kangaroo apples** (used in birth control pills) are now grown overseas (8 Ways 2021).

This continent is home to the oldest continuous living culture (Klein 2016) – an ancient source of information and knowledge that can allow us to understand and connect with this land on a much deeper level. We can start to recognise this knowledge not only as 'Indigenous science', but also as part of the collective scientific knowledge we possess as humans.

> ... all groups of humans around the world and throughout history have hypothesised, experimented, made **empirical** observations, gathered evidence, recognised patterns, **verified** through repetition, made inferences and predictions, and developed branches of knowledge that helped them to make sense of the world around them and their place within it (Sambono 2018, para. 8).

Why should this matter to you?

It's possible to become part of making things right and resolving the injustices of the past. It starts with understanding that we're all connected and recognising that creating a better future happens together. One way non-Indigenous Australians can do this is by learning as much as possible about First Nations histories and cultures that relate to all aspects of life, including science and the separation of substances in mixtures.

Your response

Think about which parts of this learning have really interested you. What else might you like to know? How will you find out?

A brighter future is possible for all people who call Australia home, but to get there we each need to play our part. Think about what you can do to meaningfully respond to the ideas and concepts you were exposed to throughout this learning.

Here are some ideas:

- Research the medicinal applications of tea tree oil as an antiseptic, anti-fungal, antimicrobial and anti-inflammatory agent (Harley 2017) and how First Nations people have been using this medicine for thousands of years.
- Find out about more First Nations knowledges related to a topic that interests you; for example, art, fishing, dance or storytelling. Learn a few words in the local First Nations language/s where you live.
- Put up the AIATSIS map in your classroom.
- Share what you've learnt with your family and allow them to share their knowledge with you.

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Acknowledgements

Image sources

Figure 2: (c. 1900) *Aboriginal woman winnowing, watched by two men, North-West Australia* [photograph], sourced from the collections of the State Library of Western Australia and reproduced with the permission of the Library Board of Western Australia, accessed 15 September 2021.

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