

3 Separating Solutions and Mechanical Mixtures

Here is a summary of what you will learn in this section:

- Solutions can be separated by filtration, paper chromatography, evaporation, or distillation.
- Mechanical mixtures can be separated by sorting, sifting, or magnetism.

The manufacturing of cheese involves a process of separating the solid and liquid parts from milk, which is a mechanical mixture. Certain chemicals can be added to milk to cause solid globs called curds to appear and drop away from the liquid part called whey. This process is known as curdling. After this process takes place, the cheese solids can be treated in different ways, usually involving removal of additional water to make many different varieties of cheese (Figure 8.13).



Figure 8.13 Cheese is made by separating milk into different substances.

C26 Starting Point

Skills A C



Coffee Filter Chromatography

Obtain a 10-cm strip of coffee filter from your teacher. Draw a line in pencil with a ruler 2 cm from one end. Place a dot of ink from a black marker on the middle of the line. Fill a small container with water to a depth of 1 cm. Place the filter strip in the water with the dot about 1 cm above the water, and tape the strip to a pencil (Figure 8.14).

1. Which colour was carried the farthest? Which colour travelled the least distance?
2. Why did the different colours of ink separate and travel different distances? Use the particle theory of matter to explain your answers.

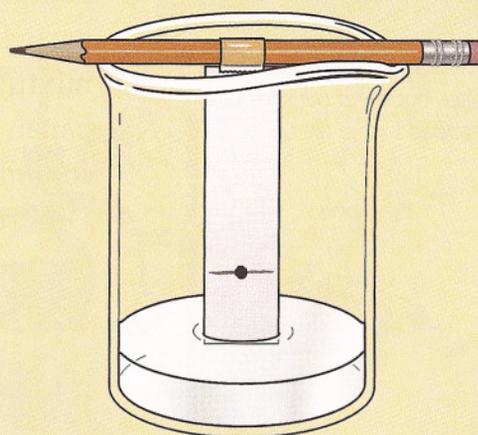


Figure 8.14 Determine which colours of ink move the farthest.

Separating Solutions

The components of a solution have very similar properties and characteristics, which makes them difficult to separate. The most common strategy involves making either the solute or the solvent change state (e.g., changing the solute from solid to liquid) so that it can be removed from the solution.

Filtration

Filtration is the mechanical process of separating solids from liquids (or gases). A filter can be used to separate the solid bits from a mixture of dirt and water (Figure 8.15). When the solution is poured into the filter, the solid parts become trapped in the filter, while the water passes through the filter. Salt or other minerals dissolved in the water will pass through the filter and remain in the water.

Automatic coffee makers use a filter to make coffee. The water passes through the coffee grounds, which creates the coffee solution, leaving the coffee grounds in the filter.

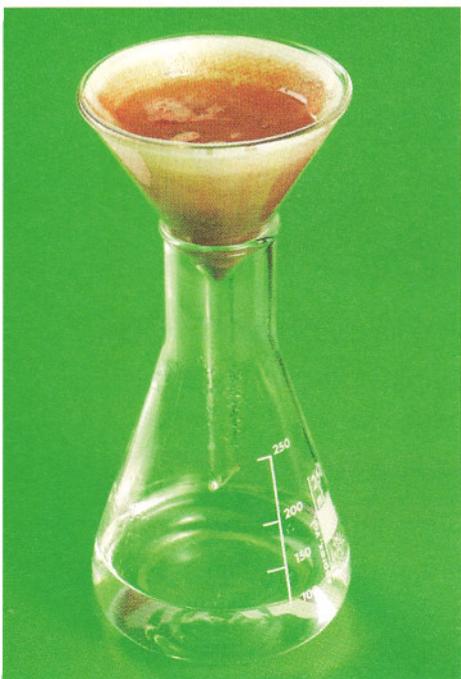


Figure 8.15 Water passes through the filter, but larger particles of dirt are trapped by the filter.

Paper Chromatography

In **paper chromatography**, a highly concentrated solution is placed on a single spot and is absorbed by the paper (Figure 8.16). The paper is dipped in a solvent, such as water, so that the spot is above the solvent. The solvent moves through the paper because the solvent particles are attracted to the paper particles and to one another. Different substances within the mixture dissolve and are carried by the solvent through the paper. The distance that a substance moves depends on its solubility in the solvent and its attraction to the paper. Different compounds travel different distances from the starting point and become separated.

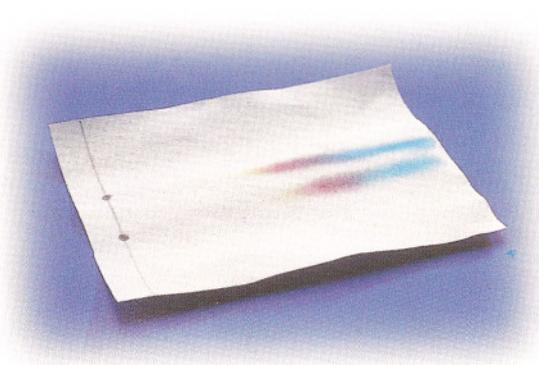


Figure 8.16 In paper chromatography, colours separate based on solubility and attraction to paper.

Evaporation

During the process of **evaporation**, water particles in a container leave the liquid (as vapour) and mix with surrounding air particles. Figure 8.17 shows that the escaping water particles have more energy and are moving faster than the remaining particles. They have enough energy to escape from the surface of the liquid. If the liquid is a solution, then the concentration of solute will increase because the number of solute particles remains constant while the number of water particles decreases. Over time, if all of the water particles leave the solution, then only the solute particles will be left behind, as they have been separated from the water. Thus, evaporation allows the solute to remain but not the solvent.

You already learned that maple syrup is made by boiling maple sap. This process causes the water in the maple sap to evaporate, which leaves behind a concentrated solution of maple syrup.

Distillation

Distillation enables you to retain both the solute and the solvent from a solution. During the distillation process, the solution is boiled. This vaporizes the solvent (turning it into a gas) and separates it from the solute (Figure 8.18). Then the gas condenses on a relatively cool surface and is collected. This separation technique is useful for substances with large differences in boiling points.

Some types of bottled water are created by distillation. This process is common when creating drinking water from salt water. Distillation removes the salt from the water, which makes it drinkable.

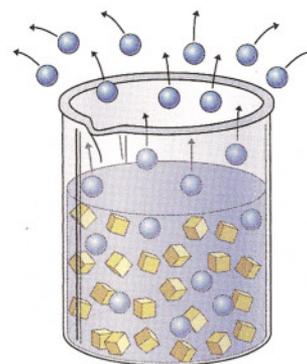


Figure 8.17 Evaporating solvent particles leave solution, while solute particles remain in greater concentration.

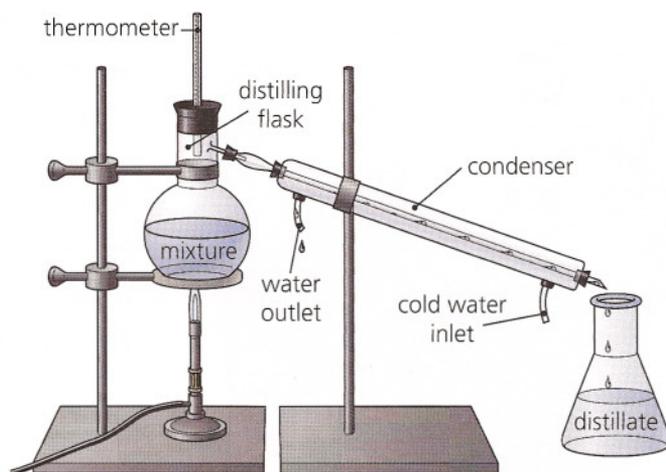


Figure 8.18 Distillation separates substances using boiling and condensation. In this apparatus, cold water is used to cool the vapour in the condenser.

Checking the Meaning of Key Words

Slowing the pace of reading, rereading, or pausing to think are effective strategies to monitor comprehension. Checking the meaning of key words is another.

While reading this section, write down a list of terms that you do not understand. You can make vocabulary cards to help you understand their meaning (Figure 8.19). To get you started, here are a few terms from the first part of the section:

- chromatography
- filtration
- distillation
- evaporation

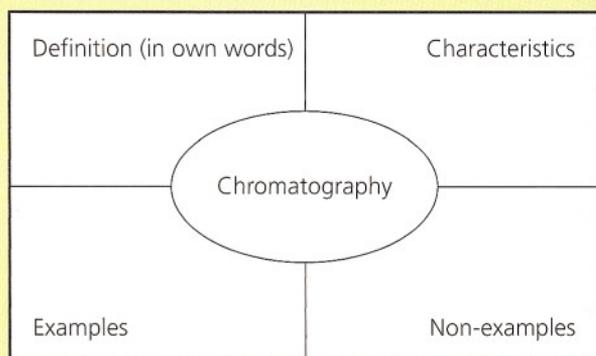


Figure 8.19 Vocabulary cards are useful for helping you to understand terms.

Separating Mechanical Mixtures

Generally speaking, separating mechanical mixtures is easier than separating solutions because the components of the mechanical mixture are usually quite different from each other. In some cases, the components of mechanical mixtures are easy to see and are easily identifiable.

Sorting

Sorting is a technique that involves separating substances on the basis of appearance, which may involve colour, size, texture, or composition. Figure 8.20 shows a blue box with a number of recyclable items. Some curbside recycling programs require the driver of the recycling truck to place the contents of the blue box into appropriate bins. Metal objects are separated from glass items, and plastic containers are separated from paper products. These separate groups of objects are then recycled. For example, aluminum cans are melted down and recycled as new aluminum cans. Some paper products are recycled for use in printing newspapers.



Figure 8.20 You can sort recyclable materials into different bins for easier recycling.

Sifting

Sifting is a means of separating solids by component size. It involves shaking or agitating a solid material while it passes through a screen or mesh. For example, bakers sift flour to remove larger clumps, which helps to make the pastries light and fluffy (Figure 8.21). Components of the solid materials that are small enough to pass through openings in the sifting device are separated from larger components that cannot fit through the same openings.

Although it seems like they are similar techniques, sifting is different from filtration. Filters tend to have much smaller holes than screens used for sifting. As a result, a solid that would pass through a screen would not pass through a filter. Also, filtration is used to separate solids from liquids or gases, whereas sifting separates solids from other solids.

Magnetism

Some metals are **magnetic** because their component particles are attracted to the particles within magnets. Iron, steel, nickel, and some compounds are highly attracted to magnets, whereas most other substances are not. Therefore, a magnet can be used to separate magnetic materials, such as automobile parts made with iron, from those materials that are not magnetic, such as plastic dashboards, foam insulation, and the rubber tires of cars (Figure 8.22).



Figure 8.22 A magnet will pick up some types of metal but not others.



Figure 8.21 Pastry chefs sift flour to keep cakes and pastries light and fluffy.

Take It Further

Recycling programs are in place throughout Canada and around the world. These programs successfully divert waste items from disposal in solid waste landfills. Many products that you use everyday have been made from recycled materials. Find out more about the sources of recycled materials. Begin your search at [PearsonScience](http://PearsonScience.com).

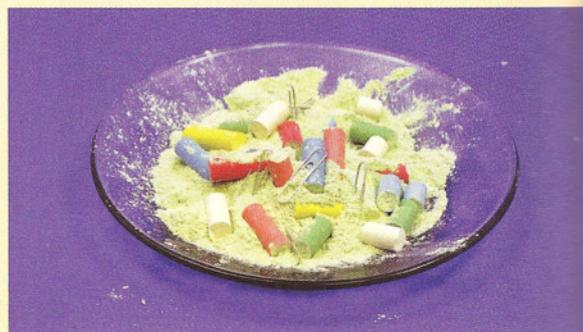
Key Concept Review

1. Use the terms “dilute” and “concentrated” to explain the difference between maple sap and maple syrup.
2. Explain the difference between evaporation and distillation. Provide an example of each method of separating solutions.
3. Explain why separating a solid mixture is often easier than separating components of a solution.
4. Most types of commercial flour are sifted before they are packaged and sold in the store. What effect do you think this has on the quality of the flour?
5. Explain how paper chromatography could be used to separate a mixture of different-coloured inks.

Connect Your Understanding

6. Explain what steps you could take to purify water for drinking if you were not sure about the water quality.
7. Explain why landscapers might sift soil that they use to construct gardens.

Practise Your Skills



8. You are given a mixture of chalk dust, larger pieces of blackboard chalk, paper clips, and salt. Draw a well-labelled flowchart to explain how you would separate each substance in the mixture.

For more questions, go to PearsonScience. 

C30 Thinking about Science and the Environment



Carbon Removal and the Environment

In Ontario, four generating stations burn coal to produce electricity. The resulting mixture of waste gases includes a great deal of carbon dioxide. In the future, it may be possible to separate carbon dioxide from the waste gases and store it underground, perhaps in abandoned mines.

Work with a partner. Think about some of the benefits that might come from carbon dioxide removal. Additionally, think about some of the negative consequences that could result. Write your ideas in your notebook, and be prepared to discuss your thoughts in small groups or with the rest of the class.