8 Mixing and separating

Planning page

Getting started

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- Investigate 18 Soluble or insoluble?
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8.3 Separating mixtures
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- Investigate 19 Filtering and decanting
- Investigate 20 Evaporating and distilling
- Experiment Water purification
- Investigate 21 Paper chromatography
- Animation Froth flotation
- Assessment task 8 Separating a mixture

Main ideas

- Chapter 8 crossword

Review and Lab review

- Chapter 8 test

Essential learnings for Chapter 8

Essential Learnings	References		
	Student book (page number)	Workbook (page number)	Teacher Edition CD (Assessment task)
Knowledge and understanding *Natural and processed materials* Matter can be classified according to its structure	pages 161–167	page 63	
Ways of working Conduct and apply safety audits and identify and manage risks	Investigate 18 pages 163–164 Investigate 19 pages 169–170 Investigate 20 pages 172–173 Experiment page 175 Investigate 21 page 177		Assessment task 8 Separating a mixture
Draw conclusions that summarise and explain patterns, and that are consistent with the data and respond to the question	Investigate 18 pages 163–164		
Identify problems and issues, formulate scientific questions and design investigations	Experiment page 175 Investigate 21 page 177	Exercise 1 page 61	
Select and use scientific equipment and technologies to enhance the reliability and accuracy of data collected in investigations	Experiment page 175 Investigate 21 page 177		Assessment task 8 Separating a mixture
Plan investigations guided by scientific concepts and design and carry out fair tests	Experiment page 175 Challenge 8 page 167		Assessment task 8 Separating a mixture

QSA *Science Essential Learnings by the end of Year 9*

Vocabulary

chromatography
colloid
concentrated
condense
decant
dilute
dissolve
distillation
evaporate
filter
insoluble
mixture
properties
pure substances
saturated
solute
solution
solvent
suspension

Focus for learning

Solve problems that involve the separation of everyday mixtures (page 160).

Equipment (per group)

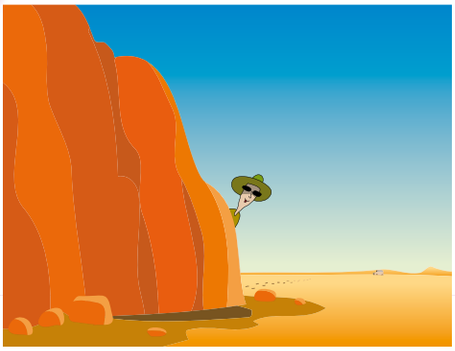
Investigate 18 pages 163–164	test tubes (at least 6), rubber stoppers, test tube rack, spatula, marking pen, alcohol or methylated spirits (in a dropping bottle), samples of salt, sugar, coffee, flour, iodine (solid), jelly crystals and grass (ground up)
Activity page 165	olive oil, vinegar, test tube, stopper, mustard powder, hypo crystals, water, beaker, dilute hydrochloric acid
Investigate 19 pages 169–170	soil, three 250 mL beakers, 2 or 3 pieces of filter paper, filter funnel, retort stand and ring clamp, glass stirring rod, teaspoon, wash bottle
Investigate 20 pages 172–173	**Part A:** copper sulfate solution (0.5 M), boiling chips, 250 mL beaker, Bunsen burner, heatproof mat, watch glass, gauze mat, tripod **Part B:** same as for Part A, plus conical flask, one-holed stopper, 40 cm length of glass tubing, 2 retort stands and clamps, test tube
Experiment page 175	200 mL sample of creek water (students will design a plan to purify it)
Investigate 21 page 177	various coloured inks from biros, felt pens and marking pens, food colourings, 250 mL beaker, filter paper or blotting paper, dropper, scissors, adhesive tape, jelly beans or Smarties, small paint brush

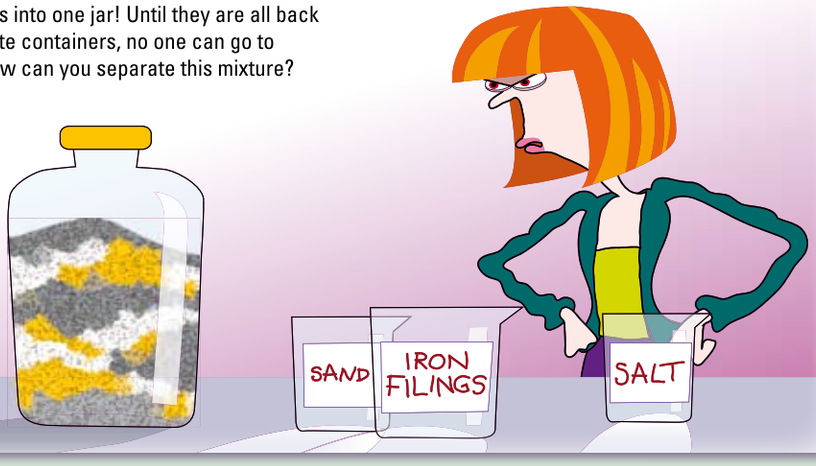
8 Mixing and separating

Getting Started

Work in a small group to solve one or more of these problems.

- Your four-wheel drive has broken down in the middle of the Simpson Desert and you have no water to drink. You find a damp patch of sand near the base of a cliff. How can you get drinkable water from this damp sand?
- Your uncle has given you a large bottle of 5c, 10c, 20c and 50c coins. Can you design a device to separate the coins?
- Your science teacher is very angry with the class. Someone has poured sand, salt and iron filings into one jar! Until they are all back in separate containers, no one can go to lunch. How can you separate this mixture?





Starting point

Ask students to work through the Getting Started problems and discuss their ideas in small groups. You might like to discuss the solutions to the problems as a whole class.

Ask students to list common methods that they have used, either at home or at school, to separate things. They should construct a table and write down the name of the method used and the situations in which this method was required and why. This will give students a study summary table, which they can add to as they work through the chapter.

This unit will require more preparation and planning than previous chapters. Make sure equipment request forms and chemical risk assessment forms are completed. Ask your lab technician for ideas and help if you are unclear of what is expected before you undertake practical activities.

8.1 What's a mixture?

Different substances have different **properties**. For a start, they can be solids, liquids or gases. But there are many other properties which allow you to tell one substance from another. For example, you can detect sugar by its sweet taste. You can detect kerosene by its smell. Glass is transparent (you can see through it). Diamond is extremely hard. Beetroot is a purple-red colour. A piece of lead is very heavy. And so on.

The materials around you can be grouped into pure substances and mixtures. **Pure substances** contain only one substance. They always have the same properties, no matter where they come from. Examples are sugar, gold, pure water and helium gas. However, most materials around you are **mixtures**—several different substances mixed together. Examples are air, soft drink, concrete and lipstick.

The amounts of each part of the mixture (called their *proportions*) can vary widely. This changes the properties of the mixture. For example, concrete is a mixture of cement, sand, gravel and water. Mixing these four substances in different proportions will change the properties of the concrete.

Fig 3 Lipstick is a complex mixture.

Lipstick normally contains:

- *castor oil*
- *beeswax*
- *carnauba (to stop it melting)*
- *esters (to make it slippery)*
- *anti-oxidant (to stop it going off)*
- *aloe (to stop lips becoming dry)*
- *mineral oil (to make lips glossy)*
- *red dye No. 21*
- *perfume*

The parts of mixtures can be solids, liquids or gases. For example, soft drink is a mixture of water and carbon dioxide gas, plus sweetener, flavouring and colouring.

Examples	Type of mixture	Main parts of mixture
black coffee	solid in liquid	coffee powder in water
air	gas with gas	nitrogen and oxygen
soft drink	gas in liquid	carbon dioxide in water
smoke	solid in gas	tiny bits of soot, dust, etc in air
wine	liquid in liquid	alcohol in water
brass	solid with solid	copper and zinc

Check!

1 Which of the following are mixtures, and which are pure substances?
   a air
   b petrol
   c polluted water
   d gold
   e orange juice
   f sugar
   g helium gas
   h concrete

2 Copy and complete these sentences.

   The features by which a material can be identified are called _____. Materials that always have the same properties are called _____ substances. Materials that are made up of different substances are called _____.The properties of a mixture can _____.

3 Explain why concrete is a mixture and not a pure substance.

4 In your notebook, match up the following types of mixtures with the examples.

a	mixture of gases	smoke
b	mixture of solids	air
c	mixture of gas in liquid	soil
d	mixture of solids in liquid	muddy water
e	mixture of solids and gases	lemonade

Research

Ask students to research the properties of an alloy: what it is used for, what metals are used to produce it and the percentage of each.

Homework

Have students make a list of mixtures and pure substances found in their kitchen pantry.

Learning experience

Students can make cement and test its strength by changing the proportions of the mixture.

You will need the following items for each group: cement, sand, gravel, water, newspaper, plastic container for mixing and another container for the mould, and measuring cups.

As a class group, research the ratio of cement to sand to gravel to water recommended for general concreting such as paths. Alter these ratios and divide the class into groups to make concrete blocks with different specifications. Have groups decide how they will test the strength of their concrete. Make sure it is a fair test. They should write up their test, make conclusions and evaluate their results.

Explain to the class that alloys are made in a similar way. Different metals are combined in varying ratios in order to develop materials that have different properties, such as increased strength, greater heat effectiveness, decreased brittleness, more malleability, less corrosiveness etc. Examples of alloys include bronze, chrome, stainless steel and steel.

Check! solutions

1 The mixtures are air, petrol, polluted water, orange juice and concrete. The pure substances are gold, sugar and helium gas.

2 The features by which a material can be identified are called **properties**. Materials that always have the same properties are called **pure** substances. Materials that are made up of different substances are called **mixtures**. The properties of a mixture can **vary**.

3 Concrete is a mixture because it is made by blending several different materials together. These materials include sand, gravel, water and cement. Depending on the amounts of each, the properties can vary. Some mixtures are suitable for paths, while others are suitable for laying bricks.

4 The arrows show the matches:

a	mixture of gases	smoke
b	mixture of solids	air
c	mixture of gas in liquid	soil
d	mixture of solids in liquid	muddy water
e	mixture of solids and gases	lemonade

8.2 Solutions

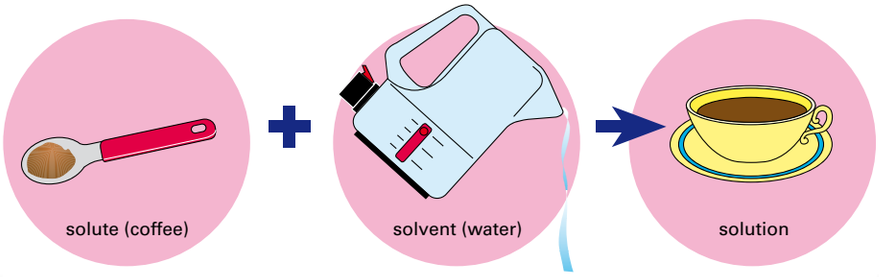
When you stir sugar in a glass of water, it disappears into the water. We say it **dissolves** in the water. The sugar and water have mixed to form a **solution**. Solutions are very important to you. The food you eat is digested and dissolved in water. It is then carried around your body in the blood plasma, which is a solution consisting of about 90% water. The wastes produced by your body are also carried away in this solution.

A solution is a special mixture that looks and behaves like a single substance. It consists of a liquid and the dissolved substance which is spread evenly throughout it. Consider what happens when instant coffee dissolves in hot water. The substance that dissolves (the coffee) is called the **solute**. The substance that does the dissolving (the water) is called the **solvent**. So the solute dissolves in the solvent, forming a solution.

Two liquids can also form a solution. For example, wine is a solution of alcohol (solute) in water (solvent). Fuel for two-stroke motor mowers and outboard engines is a solution of oil in petrol.

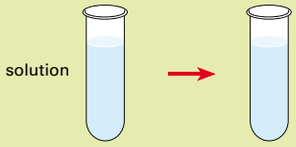
A particular substance may not dissolve in every solvent. For example, salt is soluble in water, but insoluble in alcohol. Water is an excellent solvent, but to dissolve some things you have to use other solvents. Some commonly used solvents are shown in the table below.

Solute	Solvent (dissolves the solute)
nail polish	nail polish remover
biro stains	methylated spirits
grease marks on clothes	eucalyptus oil
oil-based paint	turpentine
tar on car paintwork	kerosene

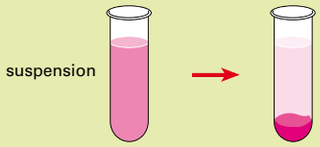


When substances don't dissolve

A substance that dissolves is said to be *soluble*. A substance that will not dissolve is *insoluble*. Some insoluble substances sink in water (settle out), and others float on top. If you shake up an insoluble solid (such as chalk dust) with water it may seem to dissolve at first. However, if you look closely you will see that the liquid is cloudy and the chalk settles when you let it stand for a while. Such a mixture is not a solution, but a **suspension**. Muddy water is another example of a suspension, because the mud settles to the bottom when you let it stand.



In a solution, the solid does not settle on standing.



In a suspension, the solid settles on standing.

Hints and tips

Draw a table on the board listing some solutions and ask the students to write down what the solute and solvent are likely to be. It would be interesting to talk about blood being a suspension and why centrifuges are often used to aid blood analyses.

Learning experience

To reinforce the importance of the words *solvent*, *solute*, *solution*, *soluble*, *insoluble* and *suspension*, ask students to write a paragraph using these words to describe meal preparation in the kitchen.

Learning experience: class demonstration

You may choose to do one of the following.

- Mix different solvents with various solutes to form different solutions.
- Mix water and oil or water and kerosene to demonstrate insoluble substances, and use a separating funnel to show how they can be separated from each other
- Make a suspension by crushing some chalk and adding it to water. Alternatively, mix equal amounts of lead nitrate and iron sulfate. Then use a centrifuge or filter paper or allow settling to separate the solid from the liquid.

Investigate

18 SOLUBLE OR INSOLUBLE?

Aim

To test whether various substances are soluble in water and in alcohol.

Materials

- test tubes (at least 6)
- rubber stoppers to fit test tubes
- test tube rack
- spatula
- marking pen
- **alcohol** or **methylated spirits** (in a dropping bottle)
- samples of:
  salt
  sugar
  coffee
  flour
  iodine (solid)
  jelly crystals
  grass (ground up)

Flammable

Toxic

Planning and Safety Check

Before you start, check that you know the safety rules for your laboratory.
Read through both parts of the investigation, then prepare a data table like the one below.

Substance	Soluble in water?	Soluble in alcohol?	Observations
salt			
sugar			
coffee			
flour			

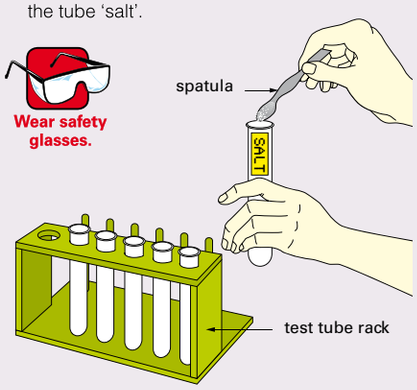
- Why do you have to be careful when using iodine? How do you dispose of leftover iodine?

Warning: Do not touch iodine with your fingers. It is poisonous. Your teacher will tell you how to dispose of any leftover iodine. Do not wash it down the sink.

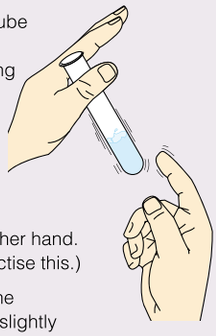
PART A
Is it soluble in water?

Method

1 Use the spatula to pick up a small amount of salt—about the size of a grain of rice. Place this salt in a test tube. Use the marking pen to label the tube 'salt'.



2 One-third fill the test tube with water. Shake the tube using the following method. Hold the tube firmly between your thumb and index finger. Then tap the bottom of the tube sharply with the index finger of your other hand. (You may need to practise this.)



Record whether the substance is soluble, slightly soluble (a bit dissolves) or insoluble.

Record any other observations as well. For example, if a solution was formed, what colour was it? Was a suspension formed?

3 Repeat Steps 1 and 2 for each of the other samples.

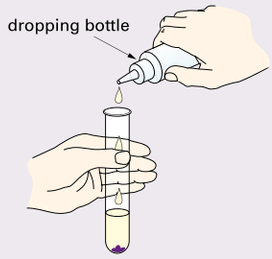
Lab notes

Prior to commencing this investigation, ensure that all groups have read the Planning and Safety Check thoroughly and are clear on what needs to be done. Also make sure a data table has been drawn up to record results and observations.

- Iodine is hazardous, so in some class situations this part of the investigation may be better done as a demonstration.
- Prepare the chemicals in small bottles for each group.
- Emphasise to students that they should not put their finger or thumb over the top of the test tube when they shake or swirl it. Students should practise the technique in Part A Step 2 to become competent in this technique before they attempt this investigation.

PART B
Is it soluble in alcohol?

Repeat Part A, using alcohol or methylated spirits instead of water.



Discussion

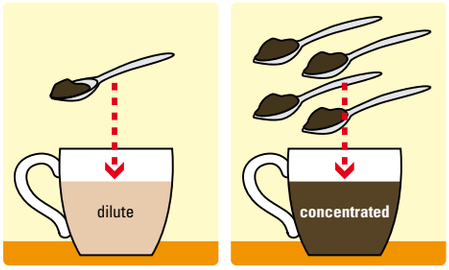
1. How can you tell whether a substance has dissolved or not?
2. Which substance dissolved most easily in water?
3. Compare the solubilities of the substances in water and in alcohol.
   - **a** Which substances were soluble in water but not in alcohol?
   - **b** Which substances were soluble in alcohol but not in water?
   - **c** Which substances did not dissolve in either water or alcohol?
4. Suppose you have a biro stain on your school uniform. How could you remove it?

Solubility

A cup of coffee is like any liquid solution. It comes in many different strengths. If you like your coffee stronger, add more coffee powder. If you like it weaker, add less coffee.

We use the terms **dilute** (dye-LOOT) and **concentrated** (CON-cen-TRAY-ted) to help us compare solutions. A dilute solution contains only a small amount of solute in a given volume of solvent. A concentrated solution contains a large amount of solute in the same amount of solvent. You may have used the terms *weak cordial* or *strong coffee*—but the correct scientific terms are *dilute cordial* and *concentrated coffee*.

The colour of a solution gives you some idea of its concentration. The darker the colour, the higher the concentration. Or, a more dilute solution will be lighter in colour. These statements are generalisations.



There is a limit to the amount of solute that will dissolve in a solution. When a solution will dissolve no more solute, it is said to be **saturated**. Until it reaches this point, it is *unsaturated*. If you add more solute to an unsaturated solution, it will dissolve.

"THE SATURATED SOLUTION"

The amount of solute needed to saturate a solution depends on the temperature. For example, at room temperature (around 20°C) you can dissolve about 2 kilograms of sugar in a litre of water, but when the water is boiling (100°C) you can dissolve almost 5 kilograms. Most solids are more soluble in warm water than in cold water. We say that their **solubility** increases as the temperature increases. This is another generalisation.

Hints and tips

Students could write out the generalisations made about solubility.

Learning experience

Working in small groups, measure the number of teaspoons of sugar or salt that will dissolve in approximately 50 mL of water until saturation is reached.

Ask students to suggest why fine sugar dissolves faster than coarse sugar.

Repeat the experiment using warm and then hot water.

Colloids

The Yarra River in Melbourne is well known for its brown colour. This is because the clay in the water is so fine that it will not settle to the bottom, as it would normally do in a suspension. Instead the clay particles are spread evenly throughout the water, forming what is called a **colloid** (COL-OID). A colloid has properties that are in between a solution and a suspension.

The particles in a colloid may be tiny bits of solid, liquid droplets or gas bubbles. The colloid may also be a solid, a liquid or a gas. The table opposite lists the common types of colloids.

A liquid-in-liquid colloid is called an **emulsion** (ee-MULL-shun). A common example is ordinary homogenised milk, where tiny globules of milk fat are spread throughout water. It is processed by forcing the milk through small holes to break up the larger fat globules in the cow's milk. This is why the cream (the fat) doesn't come to the top on standing.

Although it is easy to see fogs, foams and emulsions, it is often hard to tell the difference between solutions and some types of colloids. One way to do this is to shine a beam of light through them. The beam can be seen in the colloid because it bounces off the tiny particles. This is why you can see the headlights of a car in fog. However, the beam cannot be seen in a solution.

Colloid	Type	Examples
sol or gel	solid in liquid	most paints, starch in water, clay in water, jelly
liquid aerosol	liquid in gas	fog, clouds, sprays from spray cans
liquid emulsion	liquid in liquid	mayonnaise, milk
solid emulsion	liquid in solid	cheese, butter, face cream
foam	gas in liquid	whipped cream, beer froth, soap suds
solid foam	gas in solid	pumice, marshmallows, meringues

Activity

A Forming an emulsion

Shake up some olive oil with vinegar in a stoppered test tube, and let it stand for a while. Do the olive oil and vinegar mix? Now add a pinch of mustard powder and shake. Allow the mixture to stand again. What do you observe now? (Salad dressing is made this way.)

Write an inference to explain your observations.

B Solution or colloid?

Dissolve a few crystals of hypo (sodium thiosulfate) in a beaker of water and shine a strong beam of light through it. Can you see the beam in the solution when looking from the side?

Now add a few drops of dilute hydrochloric acid and observe what happens to the beam.

Try to explain what has happened.

Activity note

Ask students to make an inference about why on some bottled or canned items it says to shake well before use. They could give some everyday examples they are familiar with.

Homework

Ask students to write a vocabulary list of all the new words that they have learnt in this section. Then ask them to write a sentence using each one correctly.

Skillbuilder

The **concentration** of a solution is often given as a percentage. For example, a 5% hydrochloric acid solution is dilute. A 30% solution is concentrated.

If you have a dog at home, you may sometimes wash it in a dog shampoo or flea-killing liquid. These chemicals can be dangerous, and have to be mixed with water in the correct proportions. Suppose you have to make up a 5% dogwash solution. This means you need 5 parts of dogwash dissolved in enough water to make up a total of 100 parts. That is, you mix 5 parts of dogwash with 95 parts of water. This is a 5% solution.

Questions

1. How could you tell the difference between a 1% red food colouring solution and a 5% solution?
2. The label on a bottle of cleaner says it contains 15% ammonia. If the bottle contains 200 mL of cleaner, how much ammonia is in the bottle?
3. You want to fill a 50 litre bath with dogwash solution. The instructions say to make up a 0.5% solution. How much dogwash should you use?

Check!

1. Copy and complete these sentences.
   - **a** When sugar is mixed with water, it _____. This shows that sugar is _____ in water.
   - **b** Sand is _____ in water.
   - **c** In salt water, the salt is the _____, and the water is the _____.
   - **d** The solute in a solution does not settle out, but the solid in a _____ does.
   - **e** A mixture with properties in between a solution and a suspension is a _____.
   - **f** A solution that can dissolve no more solute is _____.
   - **g** Most solids are more _____ in hot water than in _____.
   - **h** A _____ solution is one which contains a small amount of solute. When more solute is added, the solution becomes more _____.
2. Which of the following statements are true, and which are false?
   - **a** Water dissolves everything.
   - **b** Solutions are always coloured.
   - **c** Some gases dissolve in water.
   - **d** Emulsions settle out on standing.
   - **e** A solute can be a solid, a liquid or a gas.
   - **f** More solute can be dissolved in an unsaturated solution.
   - **g** Adding more water to a dilute solution will make it more concentrated.
3. Explain in your own words the difference between a solute and a solution.
4. How can you tell the difference between a solution and a suspension?
5. Imagine that while doing Investigate 18 (page 163) you noticed the following:
   - **a** Nathan put his thumb over the mouth of a test tube to shake it.
   - **b** Donna used her fingers to put a pinch of salt into a test tube.

   Explain to Nathan and Donna why their methods were unsafe.

Check! solutions

1 a When sugar is mixed with water, it **dissolves**. This shows that sugar is **soluble** in water.
b Sand is **insoluble** in water.
c In salt water, the salt is the **solute**, and the water is the **solvent**.
d The solute in a solution does not settle out, but the solid in a **suspension** does.
e A mixture with properties in between a solution and a suspension is a **colloid**.
f A solution that can dissolve no more solute is **saturated**.
g Most solids are more **soluble** in hot water than in **cold**.
h A **dilute** solution is one which contains a small amount of solute. When more solute is added, the solution becomes more **concentrated**.

2 a False
b False
c True
d False
e True
f True
g False

3 A solute is something which dissolves or disappears when it is mixed with a liquid solvent. When it disappears in the liquid it is called a solution.

4 There are two main differences between a solution and a suspension. A suspension will look cloudy because it contains small particles, and these will settle out if allowed to stand.

5 These actions are unsafe because:
a Nathan—you could have burned your finger if the solution was corrosive.
b Donna—you could have left some chemical on your finger and later put it in your mouth and caused a nasty taste or burned your tongue.

6 In your notebook, complete the table below by putting in the names of the solute and solvent for each solution.

Solution	Solute	Solvent
a sea water		
b hot chocolate		
c turpentine in which you have just cleaned a paint brush		
d bath water		
e soft drink		

7 The photo below shows three different solutions of Condy's crystals in water.
- **a** What clue in the photo suggests that the solutions contain Condy's crystals?
- **b** How do the three solutions differ?
- **c** How can you explain this difference?

8 The instructions on jelly crystals say to dissolve them in boiling water. Suggest a reason for this.

challenge

1 You have painted something with an oil-based paint. Why can't you clean the brushes with water?

2 Is fog a solution, a suspension or a colloid? Explain your answer.

3 Katy shone a beam of light through some muddy water. She could see the beam. When she tried this again the next day she could not see the beam. Explain her observations.

4 The following solutions vary in concentration. Arrange them from the most concentrated to the least concentrated.
- **a** a glass of milk with one teaspoon of flavouring
- **b** a glass of milk with half a teaspoon of flavouring
- **c** a glass of milk with two teaspoons of flavouring
- **d** half a glass of milk with two teaspoons of flavouring

5 A jug contains four glasses of milk. You want to make flavoured milk with the same concentration as **c** above. How much flavouring would you need to add?

6 Which one of the following generalisations is the most general?
- **a** The hotter the solvent the more solute it dissolves.
- **b** The hotter the water the more sugar dissolves.
- **c** Sugar dissolves better in hot water than in cold.
- **d** The hotter the water the more a substance dissolves.

Explain your choice.

7 Describe how you would make a saturated solution of sugar solution. If someone asked you to check their solution to see if it was saturated, how would you do it?

8 Design your own experiment to investigate the factors that affect how quickly sugar will dissolve in water.

9 The oceans at the poles contain 2.9% salt, but the oceans at the equator contain about 3.5%. Suggest a reason for this.

Challenge solutions

1 You can't clean the brushes with water because water won't dissolve the oil but will mix and form a suspension instead. These brushes should be washed with turpentine or some other liquid which will dissolve the oil.

2 Fog is a colloid because it is a mixture of small water droplets in the air. They are not dissolved and it is not a suspension because they will not settle out.

3 The beam of light is visible because there are tiny particles in the water. The next day these had settled from the suspension to the bottom of the container and were not visible.

4 The solutions in descending order of concentration are **d**, **c**, **a** and **b**.

5 To make flavoured milk with the same concentration as **c** you would need 8 teaspoons of flavouring.

6 The most general statement is **a**, because it does not refer to any particular solute or solvent, whereas the others do.

7 The way to make a saturated solution is to dissolve sugar in water until no more will dissolve. The way to check this is to see whether there is any undissolved sugar at the bottom of the container or try to dissolve more sugar.

8 You can only really test one factor (eg grain size or temperature) at a time. When you do so, you need to keep all other factors constant so that it is a fair test. Other factors you could test are temperature and whether it is being stirred or not. (You could possibly do this at home or your teacher may allow you to do it in class.)

9 The most likely reason for this is that at the equator, water is continually being evaporated causing the solute concentration to increase.

6

Solution	Solute	Solvent
a sea water	water	salt
b hot chocolate drink	chocolate	hot water
c turpentine in which you have just cleaned a paintbrush	paint	turpentine
d bath water	grime	water
e soft drink	gas, sugar	water

7 a The clue is the colour of the solutions.
b The three solutions differ in the intensity of the purple colour.
c An explanation for this difference is that when more purple crystals (the solute) dissolve, the colour is more intense.

8 The reason is that solids will dissolve more easily in hot solvents (eg boiling water) than in cold ones.

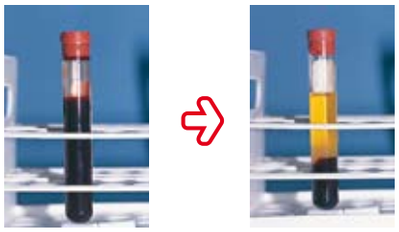
8.3 Separating mixtures

Separating suspensions

Suppose you are in the kitchen and have boiled some peas in water, but you don't want the water. You gently tip the saucepan so that the water runs out, leaving the peas in the saucepan. Pouring off the liquid like this, while keeping the solid in the container, is called **decanting**. It is a way of separating the liquid part of a suspension from the solid part.

If a suspended solid settles very slowly you can speed up the separation by using a *centrifuge*. This is a machine designed to separate mixtures by a spinning motion. A spin-drier is one type of centrifuge.

Fig 16 A high-speed centrifuge is used at the blood bank to separate the components of blood.



Normal blood

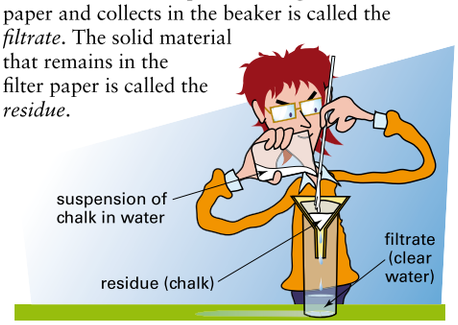
Centrifuged blood—the heavy blood cells have settled to the bottom

Centrifuges are also used to separate cream from milk, and red blood cells from plasma at the blood bank. When test tubes of blood are spun in a centrifuge (Fig 16) the heavier red blood cells settle to the bottom, leaving the pale yellow liquid plasma on top. The plasma and red blood cells can then be separated by decanting.

Decanting is not a very good method for complete separation. Some liquid is usually left behind. Also, unless you are very careful, you are likely to pour off some solid with the liquid. A better way of separating suspensions is by **filtering**.

Suppose you have a suspension of chalk in water. The chalk can be separated from the suspension using *filter paper*. The filter paper has microscopic holes in it. The water passes through these holes, but the suspended chalk cannot. This is similar to separating sand and gravel using a *sieve*. The small sand particles pass through, but the larger gravel particles do not.

The solution that passes through the filter paper and collects in the beaker is called the *filtrate*. The solid material that remains in the filter paper is called the *residue*.



Hints and tips

Students may have seen the old camping technique of tea making by swinging the billy through the air in a vertical circle to force the tea leaves to the bottom of the billy. Demonstrate the technique if they are not familiar with it.

Learning experience

Ask students to explain why a washing machine acts like a centrifuge. They should use the terms they have learnt in this topic (eg solvent, solute, solution, dissolve, filtering, centrifuge and separating).

In our day-to-day life we use *filters* to separate solids from liquids and gases. For example, vacuum cleaners have a special bag that filters dust and dirt from the air that is drawn in. The hairs in your nose filter the dust from the air you breathe. There are filters in a car to clean the petrol, air and oil. Filters are used to purify the water we drink, and to clean the water in swimming pools.

Investigate

19 FILTERING AND DECANTING

Aim

To separate a soil–water mixture by filtering and by decanting.

Materials

- soil
- three 250 mL beakers
- 2 or 3 pieces of filter paper
- filter funnel
- retort stand and ring clamp
- glass stirring rod
- teaspoon
- wash bottle

Planning and Safety Check

Read through Part A and describe to your partner what you have to do. Your partner will then describe Part B to you.

PART A Filtering

Method

1 Make a suspension by stirring about 4 teaspoons of soil in a beaker of water. Pour half of this suspension into a second beaker and let it stand for about a day.

2 Set up the filtration apparatus as shown below. Adjust the height of the stand so that the spout of the funnel touches the inside wall of the beaker. This allows the water to flow out evenly, without splashing.

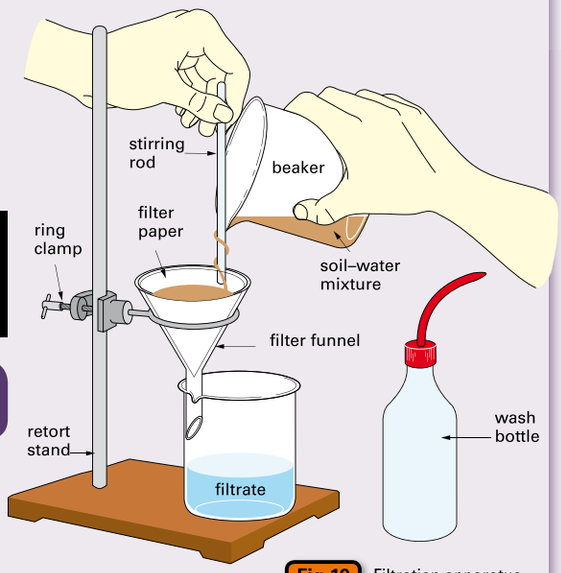


Fig 19 Filtration apparatus

Lab notes

- Give all students a filter paper, show them the correct folding method and then ask them to glue the folded paper into their notebooks.
- Students can add a few drops of water to get the filter paper to stick to the funnel.
- Remind students not to damage the paper with the glass stirring rod when trying to speed the process up.
- If no ring clamps are available the funnel will fit into the neck of a flask.
- Do not overfill the funnel or become impatient waiting for the filtrate to filter through. Only three-quarters fill it.

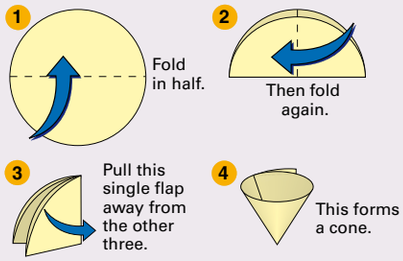
Homework

On completion of the investigation, students could be asked to draw a scientific drawing of the filtering and decanting apparatus. Ask them to label all pieces of equipment and make sure that they are drawn to scale.

Lab notes

- Initially, students might feel more comfortable using two hands to decant—one holding the stirring rod and the other controlling pouring from the beaker. With practice the one-hand method, as shown in the diagram, will become easier.
- In their conclusion, students will realise that it is faster to filter a suspension if you decant it before filtering. This eliminates excess sand and dirt particles clogging up the pores of the filter paper.

3 Fold the filter paper and open it out into a cone as shown.



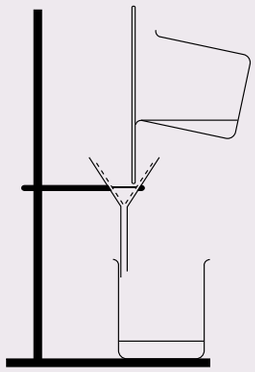
4 Place the cone into the funnel. Use the wash bottle to wet the paper so that it sticks to the sides of the funnel.

5 Hold the stirring rod as shown in Fig 19, with its lower end almost touching the filter paper. This will allow the water to flow gently into the filter paper.

Carefully pour some of the soil–water mixture down the rod into the funnel. Don't let the water level reach the top of the filter paper.

6 Use the wash bottle to rinse the remaining soil from the beaker into the filter funnel. Keep the filtrate for Part B.

7 Draw a diagram of the filtration apparatus. Draw a simple two-dimensional view as shown on the right. Notice how much simpler it is than the three-dimensional view in Fig 19. For example, there is no line across the top of the beakers, and the ring clamp has been simplified.



Neatly add the following labels:

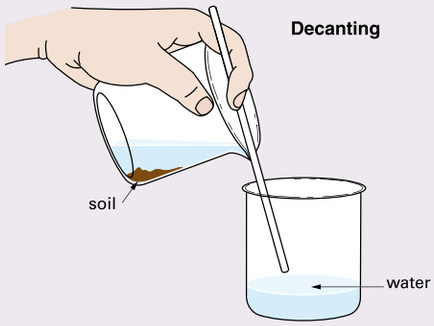
filter funnel, filter paper, filtrate, residue, stirring rod

PART B Decanting

1 Look at the beaker containing the soil–water mixture that has been standing for a day.

What do you notice?

2 Carefully decant the water into a second beaker. To do this, hold a stirring rod over the mouth of the beaker as shown below. This way the liquid runs down the rod without splashing.



Compare the decanted water with the filtrate from Part A. Is it as clear?

3 Filter the decanted water.

Discussion

1 How easy was it to filter the decanted water, compared with the original soil–water mixture? Suggest a reason for this.

2 Explain why you:

a wet the filter paper in Part A Step 4
b used the wash bottle in Step 6
c poured the suspension down a stirring rod when filtering and decanting.

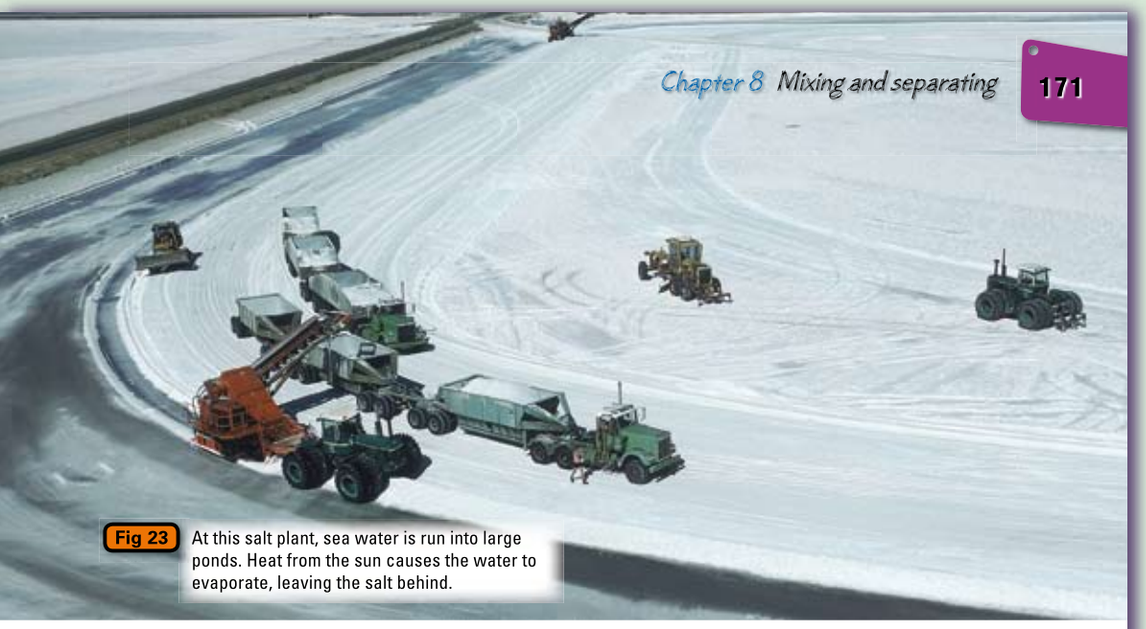


Fig 23 At this salt plant, sea water is run into large ponds. Heat from the sun causes the water to evaporate, leaving the salt behind.

Separating solutions

Once a solute has dissolved in a solvent to form a solution, you cannot separate it by filtration. The solution simply passes through the filter paper in the same way that water does.

If a solution consists of a solid dissolved in water, you can separate them by heating. The water **evaporates**—turns into a vapour and seems to disappear into the air—leaving the solid behind. Salt can be obtained from sea water by this method.

If you want the liquid you must somehow trap it as it evaporates and **condense** it back to a liquid. This process is called **distillation**. In a solar distillation plant, the sunlight passes through glass plates and the heat causes salty bore water (from underground) to evaporate. The water vapour condenses on the glass roof, and the water droplets run down the inside of the glass plates into the collection gutter. The water is pure, because the salty solutes have been left behind.

Distillation can also be used to separate two or more liquids with different boiling points, eg water and alcohol. This process is used in the making of whisky and brandy, and in the separation of crude oil into petrol, kerosene, diesel fuel and lubricating oil.

WEBwatch

To find out how to make a simple solar still, go to www.scienceworld.net.au and follow the links to **Solar still**.

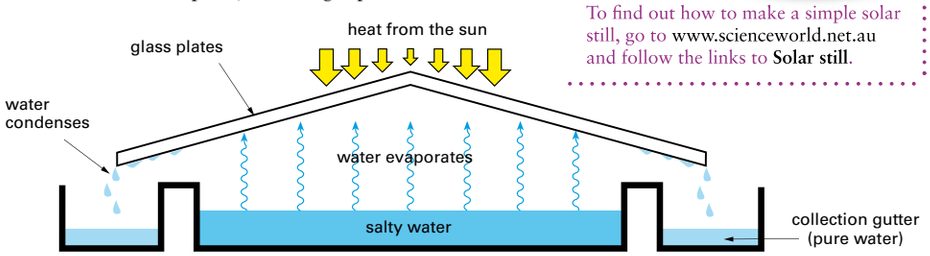


Fig 24 How a solar distillation plant works

Hints and tips

There are a lot of new words and meanings for students to remember in this chapter. It is worth getting them to set aside a page just for new words, their meaning and an example to illustrate the meaning if applicable. Reinforce words and meanings each lesson by asking 'Quick Questions', using flash cards or doing quizzes. The students will soon recognise that you think it is important to remember these words, so they will make an effort to do so.

Learning experience: making a crystal

Discuss crystal formation with the class. Crystals form as a result of the evaporation of the solvent in a solution. The slower the process, the more time the crystals have to form, which results in larger crystals. Make saturated solutions of copper sulfate or aluminium sulfate. Pour equal amounts into three watch glasses. Place one on a window sill, one in a dark cupboard, and gently evaporate the other with a heat source (preferably a hotplate). Compare the crystal growth and size.

Learning experience

Perform a teacher demonstration evaporating water from salt water. Make sure to wear safety glasses and keep students at a safe distance away from the demonstration as the salt will spit towards the end of the evaporation process.

Learning experience

The students could do a mini research project which they present to the class on a distillation and/or purification process. Research how eucalyptus oil, rose oil or other perfumed oils are collected, or explore water purification.

Lab notes

- To do Parts A and B thoroughly will take several lessons.
- For the lab technician: the glass bending is tricky—a flame spreader helps.

Part A

- Evaporating the water requires special care. Safety glasses and aprons must be worn because the solution may spit.
- Students need to be warned about turning off the burner and waiting before touching the watch glass or the beaker to avoid burnt fingers and/or breakages.
- Students need to put their watch glass on a piece of paper and label it with their name to avoid confusion or dispute.
- Explain what boiling chips are and what they do. Boiling chips are usually small pieces of porcelain or marble that minimise the amount of bumping (large bubbles) that can break the beaker and can cause the boiling liquid to well up and spill over onto the bench or burner.
- Explain how this method of evaporating is the best way to form crystals from a solution. Directly heating the solution in an evaporating basin using a burner causes dangerous spitting of the hot solid, and you get a powder rather than crystals.

Investigate

20 EVAPORATING AND DISTILLING

Aim

To separate the solute and the solvent in a solution by evaporation and by distillation.

PART A
Evaporation

Materials

- **copper sulfate** solution (0.5M) — Toxic
- boiling chips (broken porcelain)
- 250 mL beaker
- Bunsen burner
- heatproof mat
- watch glass
- gauze mat
- tripod

Wear safety glasses.

Planning and Safety Check

Read the Method for Part A.

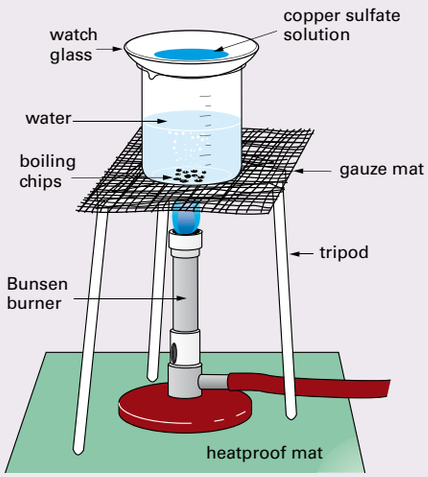
- Suggest why you put the watch glass on top of the beaker of boiling water, instead of directly on the gauze mat over the burner.
- Suggest why you don't evaporate the copper sulfate solution completely over the burner.

RULES FOR SAFE USE OF A BURNER

1. Keep the burner away from books, and away from the edge of the bench.
2. Use a heatproof mat under the burner.
3. Always light the burner with the air hole closed.
4. Switch to a yellow safety flame when not heating.
5. The barrel of the burner gets very hot. If you have to move the burner, turn it off first. Move it by holding the base or the gas hose—not the barrel.
6. Check that the gas is off properly when you have finished.

Method

1. Put the tripod and gauze mat on a heatproof mat as shown below.
2. Half fill the beaker with water. Add some boiling chips to prevent *bumping* (violent eruption of bubbles from the bottom of the beaker).
3. One-third fill the watch glass with copper sulfate solution. Place the watch glass on top of the beaker as shown.
4. Light the burner and adjust to the blue flame. Then put it under the tripod and boil the water in the beaker. The copper sulfate solution will evaporate slowly.
5. When almost all the copper sulfate solution has evaporated, turn off the burner and let the apparatus cool. (If you heat the solution any longer it will start to splutter.)
6. Leave the remaining solution in the watch glass in a warm, protected place to finish evaporating. This process is called *crystallisation* and may take a day or two.



Discussion

1 What was left in the watch glass after a day or two?

2 In your own words, explain how evaporation caused the solute to be separated from the solvent.

3 What was the purpose of the gauze mat when heating?

4 Why is it essential to wear safety glasses for this investigation?

PART B
Distillation

Materials

Same as for Part A, plus:
- conical flask
- one-holed stopper to fit flask
- length of glass tubing (at least 40 cm long and bent as shown at right)
- 2 retort stands and clamps
- test tube

Planning and Safety Check

Read the instructions and study the diagram.
- What do you think is the purpose of the glass tubing?
- What safety precautions will you need to take?

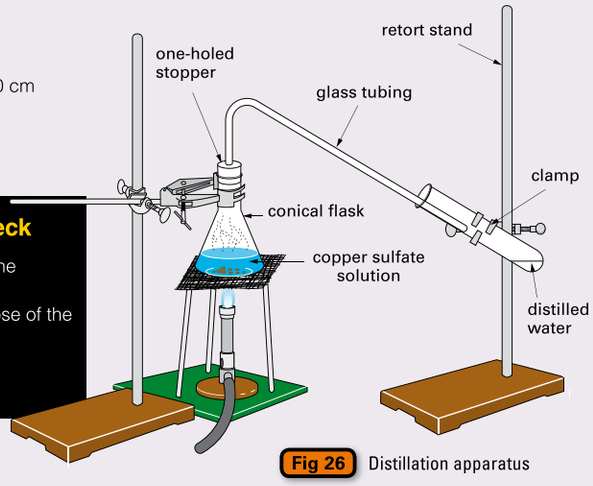


Fig 26 Distillation apparatus

Method

1 Set up the distillation apparatus as shown.

2 One-quarter fill the flask with copper sulfate solution. Add some boiling chips.

3 Put on your safety glasses. Light the Bunsen burner, adjust it to the blue flame, and heat the solution in the flask.

4 As the water boils, observe:
- **a** the water vapour rising in the flask and moving through the glass tubing
- **b** the water vapour condensing back to liquid and dripping from the glass tubing into the test tube.

5 Collect a sample of distilled water in the test tube, then turn off the burner.

Discussion

1 Explain what happened in:
- **a** the conical flask
- **b** the test tube.

2 The liquid you collected in the test tube is called the *distillate*. Why is it clear, not blue?

3 The glass tubing is called an *air-cooled condenser*. Suggest a reason for this name.

4 Design a water-cooled condenser.

Lab notes

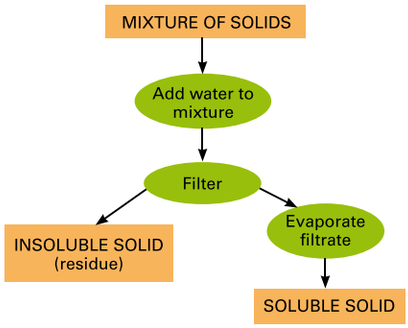
Part B

- This is quite hazardous and it may be better as a demonstration if the students are not capable of assembling this sort of apparatus.
- If you plan for the students to do this part of the investigation themselves, it is best to set up the apparatus prior to the commencement of the lesson. You can then discuss the function of the pieces of equipment and explain what will happen. Students can follow this as a model when assembling their own apparatus.
- It is a good idea to wrap some wet paper towelling around the glass tubing to assist condensation.
- Don't let the solution boil dry or the copper sulfate will turn brown and become very difficult to remove from the inside of the flask.

Separating solids

Sometimes we need to separate a mixture of solids from each other. The four methods below all depend on differences in the properties of the solids.

1 **If one solid is soluble in water and the other is insoluble, you can add water.** When you filter the mixture, the residue is the insoluble solid. The filtrate contains the soluble solid in solution. It can be recovered by evaporation. The process can be summarised in a flowchart.



2 **If one solid is attracted to a magnet and the other is not, you can use magnetic separation.** This method is used in industry to separate the magnetic minerals in mineral sands.

Fig 27 A magnet will separate the magnetic minerals in sand.

3 **If one insoluble solid floats on water and the other sinks, you can add water to the mixture and skim off the floating solid.** For example, you can separate sawdust and sand this way. Sometimes this method can be used even if both solids normally sink in water. A special chemical is dissolved in the water, and air is bubbled into it. A froth of bubbles floats to the top, taking one of the solids with it. This method is called *froth flotation*. It was invented in Australia, at Broken Hill, and is often used to separate valuable minerals from rock.

To see how froth flotation works, open the Froth Flotation animation on the CD. Working with technology

4 **If one solid is heavier than the other, you can use gravity separation.** A good example of this is gold panning. Here the water is swirled about in the pan, allowing the heavy gold to sink and the lighter mud and sand to be washed off the top. This is like decanting.

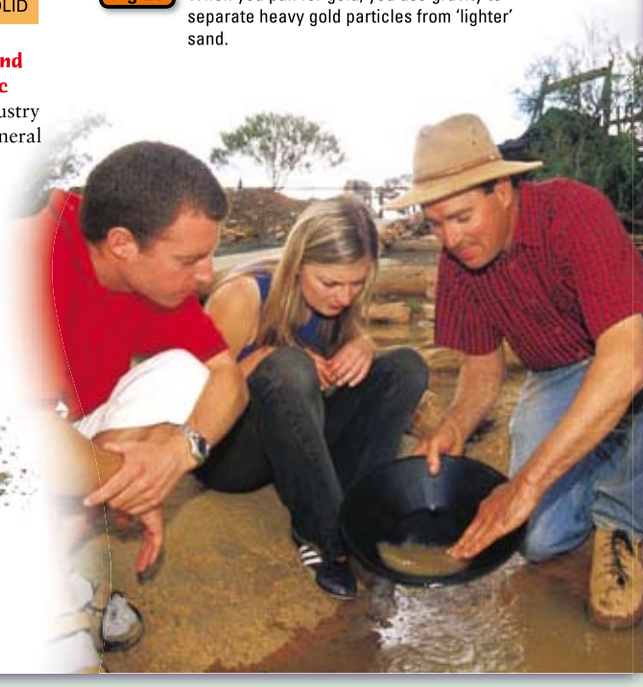


Fig 28 When you pan for gold, you use gravity to separate heavy gold particles from 'lighter' sand.

Hints and tips

If demonstrating how to separate magnetic minerals (eg iron filings) from sand or other solids, wrap the magnet in cling wrap. This way the magnet can be easily removed without having tiny pieces of iron filings stuck to it.

Animation

Students should view the **Froth flotation** animation on the CD.

Assessment task

Students could attempt **Assessment task 8**: Separating a mixture, found on the CD, after the information on this page has been discussed.

Homework

Ask students to make posters about the different separating techniques. Design the posters so that they show hints or dos or don'ts for setting up and performing these activities.

Learning experience

Visit you local water treatment plant or local manufacturing, mining or construction industry and see first hand the separation techniques that are used.

Alternatively, research some separating techniques that are used in Australian industries, and find the processes that are used and why.

In small groups, construct a flow diagram which could be used to help a person separate a mixture into its components. Show the separating techniques used and draw scientific diagrams to illustrate the separating technique in each case.

Experiment
WATER PURIFICATION

The problem to be solved

The normal water supply has broken down. The only water available is creek water, which is greenish in colour, smells, and has all sorts of things in it, eg twigs and mosquito wrigglers. How can you make this water pure enough to drink?

Method

1 Form a group with other students. Your teacher will give you a sample of about 200 mL of impure creek water. Your task is to recover as much pure water as possible.

2 Observe the creek water and record what impurities are in it.

3 In your group, discuss ways of purifying the water.

Which of the separation techniques you have learnt in this chapter could you use?

The flow diagram below shows how water is purified in a water treatment plant. Could you modify this for use in the laboratory? How?

4 Decide how you will attack the problem.
- Which technique(s) will you use?
- What equipment will you need?
- Who will do what?
- How much time will you need?

5 When you and your teacher are happy with your plan, put it into action.

Keep a record of what you did.

What was the water like after you purified it?

How much purified water did you recover?

6 If your technique isn't successful, try another. You may need to discuss the problem with your teacher. You may also need to use the library.

Writing your report

Write a report describing what you did, for someone else to read. You could prepare a poster for presentation to the rest of the class. Include a discussion of how successful your method was.

- Is your method practical?
- How long did it take?
- Would your method work for larger volumes of water?

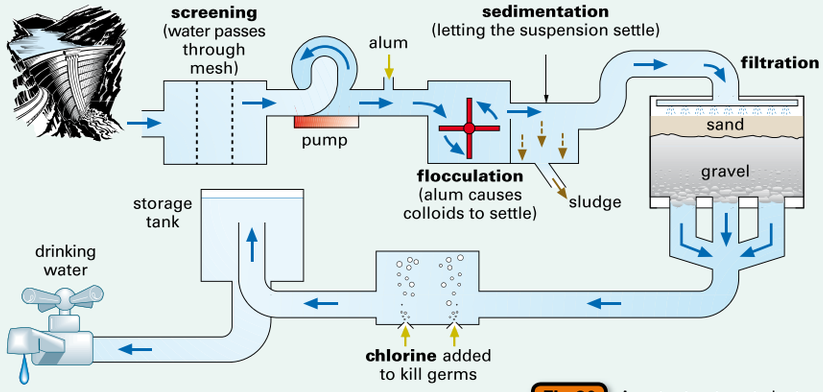


Fig 30 A water treatment plant

Lab notes

- The equipment required by groups will be much the same as that used in Investigate 19 and 20. Some groups may request special equipment, depending on their experimental design.
- Swirl or stir the suspension before distributing it to the groups.
- Make sure you have a good supply of sieves, filter funnels, sand, large plastic containers, gravel and perhaps bleach.
- An alternative to creek water is to make your own murky water. You may like to add to water a mix of chalk, salt, clay, sand and iron filings. Do not tell the students what is in the mixture as this should be part of the investigation. The process of purification will take a few lessons to complete. Make sure the students have fully explained their design brief and are aware of all safety procedures before performing the separation.

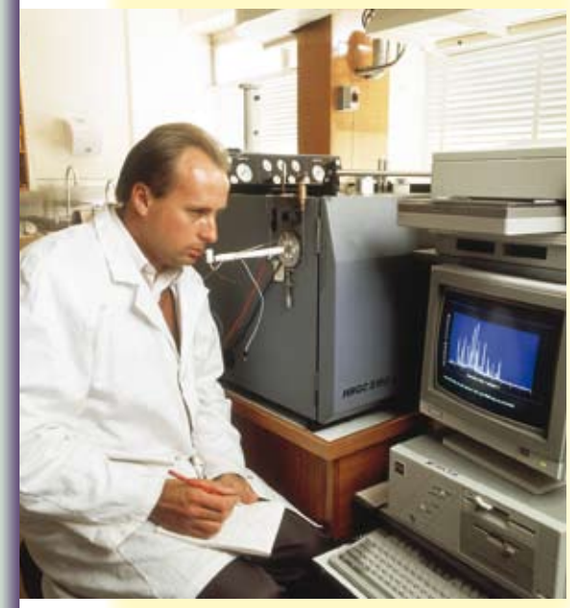
Separating colours

Chromatography (CROW-ma-TOG-ra-fee) can be used to separate a mixture of coloured substances. (*Chromos* is the Greek word for 'colour'.) For example, this method will separate the coloured substances in black ink, as shown below.

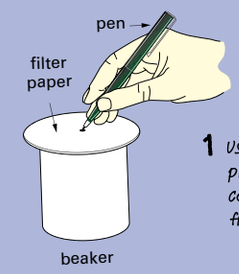
Science in action

Gas chromatography is used in industry and in scientific research to detect very small amounts of chemicals in mixtures. It is used to test the purity of medicines and to see if harmful pollutants are being released into the air.

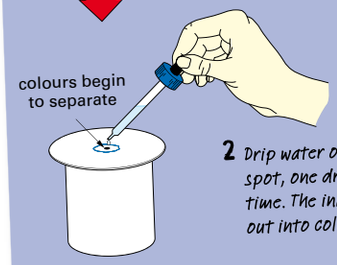
Forensic scientists use it to detect poisons and drugs in blood or traces of chemicals at crime scenes. The peaks on the graph on the monitor in the photo are the different chemicals in the sample being tested.



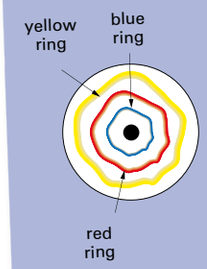
How to separate the colours in black ink



1 Use a black pen to place a spot in the centre of a piece of filter paper.



2 Drip water onto the spot, one drop at a time. The ink spreads out into coloured rings.



3 With this ink there are three rings—blue, red and yellow. This shows that the ink contains three different substances, coloured blue, red and yellow. The yellow substance is the most soluble in water. The blue is the least soluble.

Hints and tips

Students could try the activity in the purple box using different types of pens and markers. If the results are inconclusive, try methylated spirits instead of water as the solvent.

Homework

Ask students to construct a table of all the separating techniques that have been studied in this chapter and say in which situations they are best used.

Research

Get the students to investigate the different uses for chromatography: what fields of work it is used in, how it is used and what type of chromatography is involved.

Investigate

21 PAPER CHROMATOGRAPHY

Aim

To plan and carry out an investigation to separate the different coloured substances in inks or food colourings using paper chromatography.

Materials

- various coloured inks from biros, felt pens or marking pens (Indian ink works well.)
- food colourings
- 250 mL beaker
- filter paper or blotting paper
- dropper
- scissors
- adhesive tape
- jelly beans, Smarties or similar sweets
- small paint brush

Method

Use the Planning and Safety Check and the diagrams below to plan what you are going to do and how you are going to do it.

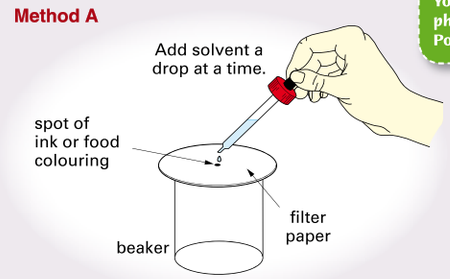
Planning and Safety Check

- You can use one or more of the three methods below.
- Black and dark colours usually give good results.
- For some inks, eg biro, you may need to use alcohol or methylated spirits instead of water as the solvent.
- To remove the food colourings from a jelly bean or similar, put it in a watch glass and add three drops of water. Brush the jelly bean with a small paint brush until the colouring dissolves in the water.
- Allow the filter papers to dry, then label them and stick them in your notebook.
- When you have finished the investigation, write a report describing in a few sentences what you found out. For example, which ink or jelly bean contains the most colours?

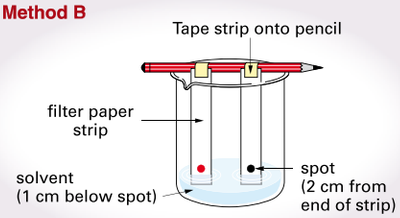
You could use a digital camera to take photos of your results and use them in a PowerPoint presentation.

Working with technology

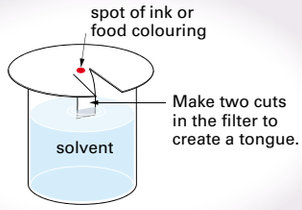
Method A



Method B



Method C



Lab notes

- The obvious temptation here is for students to eat the lollies, so it's best to only give students enough for the activity. Perhaps save some as a special treat for students at the end of the class.
- For method B a flat ice-cream stick won't roll and is a good alternative to a pencil or pen.
- It is a good idea to have the filter paper strips cut to size. Check that the papers reach the solvent but the spot is not immersed.

Check!

1 Work with a partner and give each other a spelling test of these words. Correct any mistakes.

apparatus	filter funnel
beaker	laboratory
dilute	solubility
distillation	solute
evaporation	solution

2 Look at the food strainer below. Explain how it works.

3 Why is filtering usually a better method of separation than decanting?

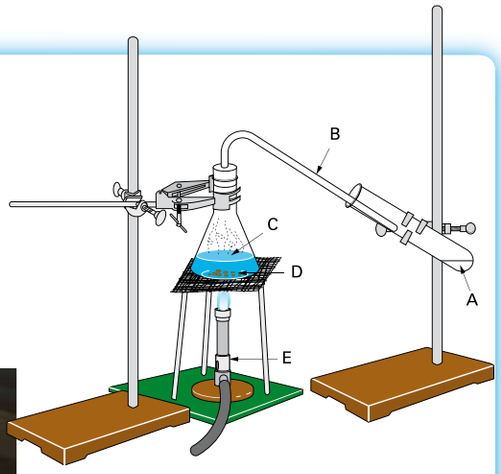
4 Suppose you filter river water which contains mud, sand, dissolved salt and some plant materials. Which of these materials will be present in:
- a the residue?
- b the filtrate?

5 What is a centrifuge? Where is a centrifuge found in most homes?

6 Write a sentence or sentences using these words correctly: condensation, distillation and evaporation.

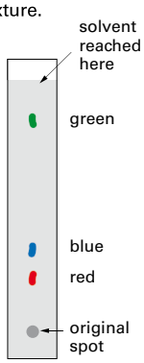
7 The diagram at the top of the page shows the apparatus used to distil salt water. Write down the correct letter for each of the following:
- a Bunsen burner
- b where evaporation takes place
- c where the vapour changes to a liquid
- d distilled water
- e where the salt stays.

8 Go back to the three problems in Getting Started on page 160. Can you now suggest other solutions?



9 Which method would you use to do each of the following?
- a separate iron filings from sawdust
- b make fresh water from sea water
- c remove the water from wet clothes
- b remove the dust from the smoke going up a factory chimney
- e separate the coloured dyes in an ink
- f separate cream from milk
- g separate a mixture of salt and pepper

10 A dye is known to be a mixture. When a spot of the dye was put on a strip of filter paper and placed in alcohol, three coloured spots appeared, as shown.
- a Why have the parts of the mixture separated?
- b Which coloured substance do you think is the most soluble in alcohol? Why?



11 Draw a simple diagram of the apparatus needed to separate a mixture of sea water and sand so that you obtain clean sand. On your diagram label at least three pieces of equipment, and show where the salt and sand end up.

Check! solutions

1 If students get any of these words wrong it would be a good idea for them to write the words out neatly ten times to help remember them.

2 The potato chips are insoluble in the oil and will not fit through the wire grill in the strainer when it is lifted out of the boiling oil. This enables the chips to be separated from the oil in which they were cooking.

3 Filtering is generally a better method of separation because when decanting it is very difficult to avoid getting some solids mixed in with the liquid.

4 If you started with river water:
- a you would have mud, sand and plant materials in the residue
- b you would have water and dissolved salt in the filtrate.

5 A centrifuge is a device which spins around quickly, flinging materials outwards. A common example in most homes is a spin dryer in the laundry, which flings water out of your clothes after they have been washed.

6 *Condensation* is when a gas cools down and forms a liquid. *Distillation* is when a solution is heated up and the solvent changes from a liquid to a gas and is later collected. *Evaporation* is when a liquid is heated and changes to a gas.

7 The correct labels are:
- a E
- b C
- c B
- d A
- e D

8 Some possible solutions to these problems:
- You could dig a hole and place your hat in it upside down so that the water will seep into it and the sand and other debris will be filtered out.
- You could use a few pizza boxes to build a series of trays with different size holes with the 20c holes in the top tray, 10c in the next and 5c in the bottom tray.
- You could first of all remove the iron filings with a magnet and then dissolve the salt, filter out the sand and then evaporate the water.

9 Methods that could be used to separate each of these mixtures:
- a Use a magnet. If you cover the magnet with some thin plastic wrap it will make it easier to remove the filings.
- b Construct a solar distillation plant, even if on a small scale (as shown in Fig 24 on page 171).
- c Place them in a spin dryer or simply twist them to squeeze the water out of the fabric.
- d Pass the smoke through special filters to remove the particles.
- e Place a dot of ink on a piece of absorbent paper and allow a solvent to move through it, separating the colours.
- f Allow the mixture to settle or use a simple centrifuge called a 'separator'.
- g Put the mixture into water and allow the salt to dissolve, filter to remove the pepper and then evaporate to recover the salt.

10 This method of separation is called paper chromatography.
- a The different colours have separated because they are not all equally soluble in the solvent.
- b Green is most soluble and is carried furthest by the alcohol.

challenge

1 In Investigate 19 (page 169) you used filtration *apparatus*. What is the difference between equipment and apparatus?

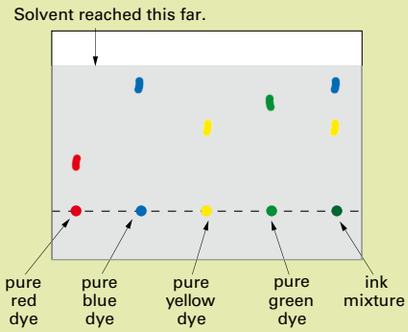
2 Why is it important to replace the filters used in cars from time to time?

3 Using Fig 16 on page 168, explain how a centrifuge works.

4 A chemist used paper chromatography to investigate some ink. Her results are shown below.

a Which different coloured dyes did the ink contain?

b Infer the colour of the ink.



5 Kirk, Nathan, Patsy and Jade each had a mixture to separate. The four mixtures (not in order) were:

a mud and water

b mud and salt

c salt and water

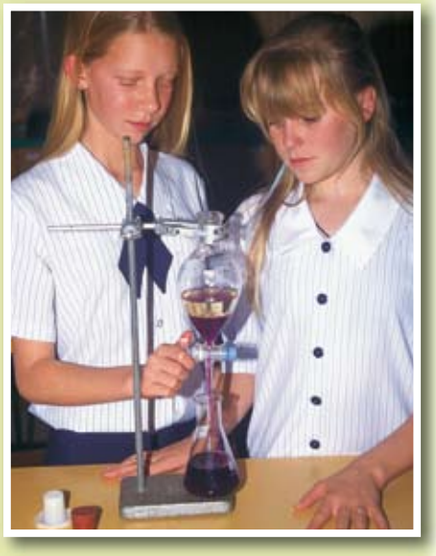
d mud, salt and water.

Patsy's first step in her separation was to add some water to her mixture. Kirk separated his mixture by decanting it. Jade had more steps in her experiment than Nathan did.
Which student separated which mixture?

6 After using an electric kettle with hard water for some time an insoluble substance builds up inside it. Infer where this comes from.

7 Look at the photo of the swimming pool filter on page 169. Describe how you think it works.

8 The photo below shows a separating funnel. It can be used to separate two liquids that do not mix, for example oil and water. Explain how you think it works.



9 Imagine you are a waste management engineer. You have been supplied with a mixture that contains sand, sawdust, iron filings and lead shot. Your task is to separate as much of each component as you can, so that they can be recycled.

10 Suppose you own a lolly shop. You suspect your supplier is selling you a cheap, inferior brand instead of Smarties, but charging you for the real thing. How could you check this?

Challenge solutions

1 Apparatus is equipment that is put together for a special purpose. For example, several pieces of equipment are assembled as filtering apparatus.

2 Filters are used on cars to clean the air, fuel and oil. They will become blocked with tiny particles and need to be cleaned or replaced regularly.

3 As a mixture is spun around, the heavier parts are flung outwards and will separate from the lighter parts. For example, with blood the cells will separate from the plasma as shown in Fig 16 on page 168.

4 Using this technique, the chemist can infer that:

a the ink contained blue and yellow dyes

b the ink was a green colour.

5 The four mixtures were separated by these students:
Kirk: mud and water
Patsy: mud and salt
Nathan: salt and water
Jade: mud, salt and water

6 The scale that builds up is material that has been dissolved in rainwater but is left behind when the water evaporates in the electric kettle.

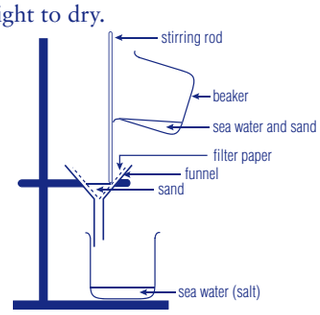
7 A pump draws some of the water from the pool through a skimmer box. This box has a coarse grid that removes leaves and other large pieces of debris before the water passes through a much finer filter where fine sediment, such as sand, is removed.

8 When two liquids do not mix, one floats above the other and a 'boundary' is visible, as shown in the photo. The tap is turned off when the bottom liquid has all gone through.

9 This is a practical activity which you may be able to try. Some methods which may be useful are using a magnet, panning, flotation and decanting.

10 A simple way to test this would be to separate the colours using a chromatography technique similar to that shown on page 176 and compare these colours with those of 'genuine' Smarties.

11 Filtration will leave wet sand which will still contain some salt. To remove all of the salt, the sand should be rinsed with pure water and filtered or decanted again several times. The sand can then be left overnight to dry.



Main ideas solutions

1 solute, solvent, solution
2 dissolves, insoluble
3 suspension
4 colloids
5 dilute, concentrated
6 properties, mixture
7 decanting, filtering
8 distillation
9 chromatography

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

1 A _____ is a substance that dissolves in a _____ to form a _____.
2 When a substance _____, it is said to be soluble. Substances which do not dissolve are _____.
3 In a _____ (eg muddy water), the solid settles to the bottom when left standing. Solutions do not settle.
4 Many everyday substances are _____, with properties in between solutions and suspensions.
5 A _____ solution contains only a small amount of solute in a given volume of solvent. A _____ solution contains a larger amount of solute.
6 Separation techniques depend on differences in the _____ of the substances in the _____.
7 Suspensions can be separated by _____, using a centrifuge or by _____.
8 A dissolved solid can be separated from a solvent by evaporation or by _____.
9 A mixture of coloured substances can be separated by paper _____.

chromatography
colloids
concentrated
decanting
dilute
dissolves
distillation
filtering
insoluble
mixture
properties
solute
solution
solvent
suspension

Try doing the Chapter 8 crossword on the CD. Working with technology

REVIEW

1 If you dissolve instant coffee in hot water, the water is the:
A solvent
B solute
C solution
D suspension

2 If more water is added to a coloured solution it becomes:
A more concentrated
B more dilute
C saturated
D a darker colour

3 Water can be separated from alcohol by:
A chromatography
B filtration
C evaporation
D distillation

4 Four liquids—water, kerosene, alcohol and petrol—were used to test the solubility of three unknown solids, A, B and C.
Georgia did the tests and recorded the mass of solid that dissolved in equal volumes of the liquids.

Solvent	Grams of solid that dissolved		
	Solid A	Solid B	Solid C
water	5	6	0
kerosene	1	1	5
alcohol	4	3	4
petrol	1	0	6

a Which liquid is the best solvent for solid B?
b If solid A was accidentally mixed with solid C, which liquid could you use to separate them? Explain your answer.

Review solutions

1 **A**

2 **B**—see page 164.

3 **D**—see page 171.

4 **a** **Water**—since it dissolves more of solid B than the other liquids do

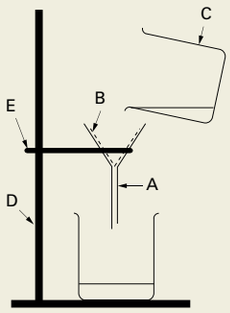
b **Water**—If you add water to the mixture of A and C, only A will dissolve. You can then separate them by filtration and evaporation.

c A mixture of A and B could be separated using **petrol**. Some of A would dissolve, and this could be recovered by evaporation. However, this is not a good method, because A doesn't dissolve very well in petrol.

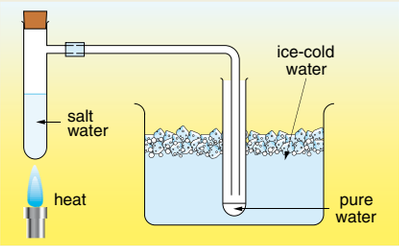
REVIEW

c Is there any way of separating a mixture of A and B?

5 Look at the diagram below.
- **a** What are the pieces of equipment labelled A–E?
- **b** Label the filtrate and the residue.
- **c** There are two mistakes in the diagram. What are they?
- **d** Redraw the diagram correctly.



6 The apparatus below can be used to obtain pure water from salt water.
- **a** What is this separation method called?
- **b** Explain how the method works.
- **c** What is the purpose of the ice-cold water?



7 When a can of fruit juice is left to stand, a sediment forms on the bottom of the can. Is fruit juice a solution, a suspension, a colloid or a combination of these? Explain.

8 **a** Write one complete and scientifically correct sentence using these words:
colloid emulsion milk
- **b** Do the same for these words:
concentrated dilute solution

9 The police receive a ransom note written using a felt pen. They also have felt pens from three suspects. How could they use paper chromatography to find out who wrote the ransom note?

LAB REVIEW

You have a mixture of salt and dirt that Ken collected on his recent trip to Lake Eyre. Your task is to separate the salt by removing the dirt.

1 Work out a way of separating the salt.
2 Make a list of the equipment you will need.
3 Do the separation correctly and safely.

For Step 3 work with a partner, who will watch what you do and note any errors you make. They will discuss these with you when you have finished. Then swap jobs and check your partner's skills.

Check your answers on pages 302–303.

c The ice-cold water lowers the temperature inside the right-hand test tube. This causes the water vapour in the tube to condense back to liquid water.

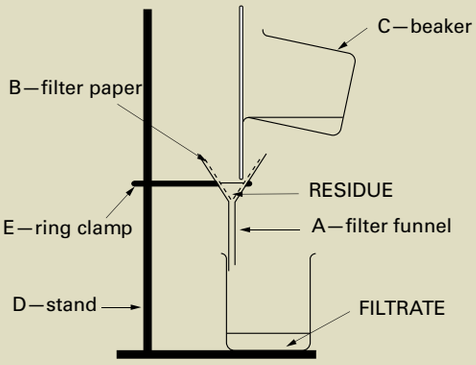
7 The fact that a sediment settles out on standing indicates that some of the fruit juice is in suspension. However some is also in solution since the liquid is coloured. And if you don't get a clear solution on settling then the fruit juice is a colloid (see page 165). So fruit juice is a solution, a suspension and possibly a colloid as well.

8 There are many possible sentences using these words. For example:
- **a** *Milk* is a liquid-in-liquid *colloid* called an *emulsion* (see page 165).
- **b** A *concentrated solution* contains more solute than a *dilute* solution (see page 164).

9 The ink in a felt pen is a mixture of several different colours. Different felt pens contain different ink mixtures, which can be separated using paper chromatography.

To start with, the police would test a sample of ink from the ransom note. Then they would test the ink from the felt pens of each of the three suspects. If they get the same pattern of colours as in the ransom note, then the owner of this pen is probably guilty. (It is of course possible that the note was not written using this particular felt pen, but with another pen of the same type.)

5 **a** and **b**



c The mixture should be poured from the beaker down a stirring rod—as shown in Fig 19 on page 169. The stem of the filter funnel should be touching the inside of the beaker.

6 **a** Distillation—see page 173.
- **b** Heating causes the water in the left-hand test tube to boil. Water vapour travels along the tube and condenses to form pure water in the right-hand test tube. The salt that was dissolved in the water is left behind in the left-hand test tube.

Lab review

1 Add water to the mixture and stir. The salt dissolves but the dirt does not.

2 Filter the mixture as in Investigate 19 on pages 169–170. The residue on the filter paper is the dirt, and the filtrate is the salt solution.
Equipment needed:
- piece of filter paper
- filter funnel
- stand and ring clamp
- wash bottle
- glass stirring rod
- 2 beakers.