Solids, Liquids and Gases **Quick Assessment**

Write the state of matter before and after in each situation. The first one has been done for you:

	State of Matter Before	State of Matter After
making ice cubes	Liquid	Solid
the wax of a lit candle		
boiling water		
heating butter		
a puddle drying out		
lava from a volcano cooling		

5 marks

Use the numbers given (not lines) to match each state of matter to its correct properties. Some properties might match to more than one state of matter:

1. liquid

2. gas

3. solid

Fixed shape.

Can flow.

Takes the shape of the container it is in.

Cannot flow.

Can be compressed (squashed).

Cannot be compressed.

9 marks

Learning Objectives:

- ☐ I can independently identify solids, liquids and gases in everyday situations.
- ☐ I can independently identify the properties of solids, liquids and gases.

Quick Assessment **Answers**

Write the state of matter before and after in each situation. The first one has been done for you:

	State of Matter Before	State of Matter After
making ice cubes	**liquid**	**solid**
the wax of a lit candle	**solid**	**liquid**
boiling water	**liquid**	**gas**
heating butter	**solid**	**liquid**
a puddle drying out	**liquid**	**gas**
lava from a volcano cooling	**liquid**	**solid**

5 marks

Use the numbers given (not lines) to match each state of matter to its correct properties. Some properties might match to more than one state of matter:

1. liquid

2. gas

3. solid

3	Fixed shape.
1, 2	Can flow.
1, 2	Takes the shape of the container it is in.
3	Cannot flow.
2	Can be compressed (squashed).
1, 3	Cannot be compressed.

9 marks

Quick Assessment **Teacher Feedback Sheet**

Effort: 1 2 3 4 5 Score: **/14**

You can correctly identify **some** solids, liquids and gases.	You can correctly identify **most** solids, liquids and gases.	You can correctly identify **all** solids, liquids and gases.
You can correctly identify **some** properties of liquids.	You can correctly identify **most** properties of liquids.	You can correctly identify **all** properties of liquids.
You can correctly identify **some** properties of gases.	You can correctly identify **most** properties of gases.	You can correctly identify **all** properties of gases.
You can correctly identify **some** properties of solids.	You can correctly identify **most** properties of solids.	You can correctly identify **all** properties of solids.

Next Steps:

States of Matter: Solids, Liquids and Gases
Teaching Ideas

Learning Objective:	To understand that matter can exist in three states.
Success Criteria:	• To define matter. • To state the three types of matter. • To compare and contrast the three states of matter.
Context:	This is the first lesson of the new topic of 'States of Matter' in key stage 3 chemistry.

Starter

As students enter the classroom and settle, on slide 3 is a question 'What is matter?' and 'How do we know it exists?' This helps the teacher to gauge how many students are familiar with the term 'matter', what evidence we have for it and can use the time to clarify any misconceptions.

Main Activities

Matter Key Points

Slides 4-5: Give background information to the students covering the basics.

Identifying Types of Matter

Slides 6-8: Students copy down the subheadings on slide 6. Students are shown slide 7 and write in pairs any solids, liquids or gases they can see in the classroom. Students are asked to circle their most unique answer as stated on slide 8. Students are encouraged to add to their notes by listening to their peers, as prompted on slide 9.

Properties of Types of Matter

Slides 9-11: Show the definition and examples of properties on slide 10. Students work in small groups to describe the properties of solids, liquids and gases, guided by questions. Support is given and also an extension task to write a description in twenty words or less.

Properties Key Points

Slides 12-14: Give background information to the students covering the key properties of solids, liquids and gases.

Solids, Liquids and Gases Activity

Students follow the worksheet to define matter, identify solids, liquids and gases in everyday situations and compare and contrast properties of solids, liquids and gases. At the end of the sheet are tick boxes that can be completed by either the student, peer or teacher matching to each point of the success criteria.

Solids, Liquids and Gases Quick Assessment

Students follow the worksheet to demonstrate their knowledge of the three states of matter by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

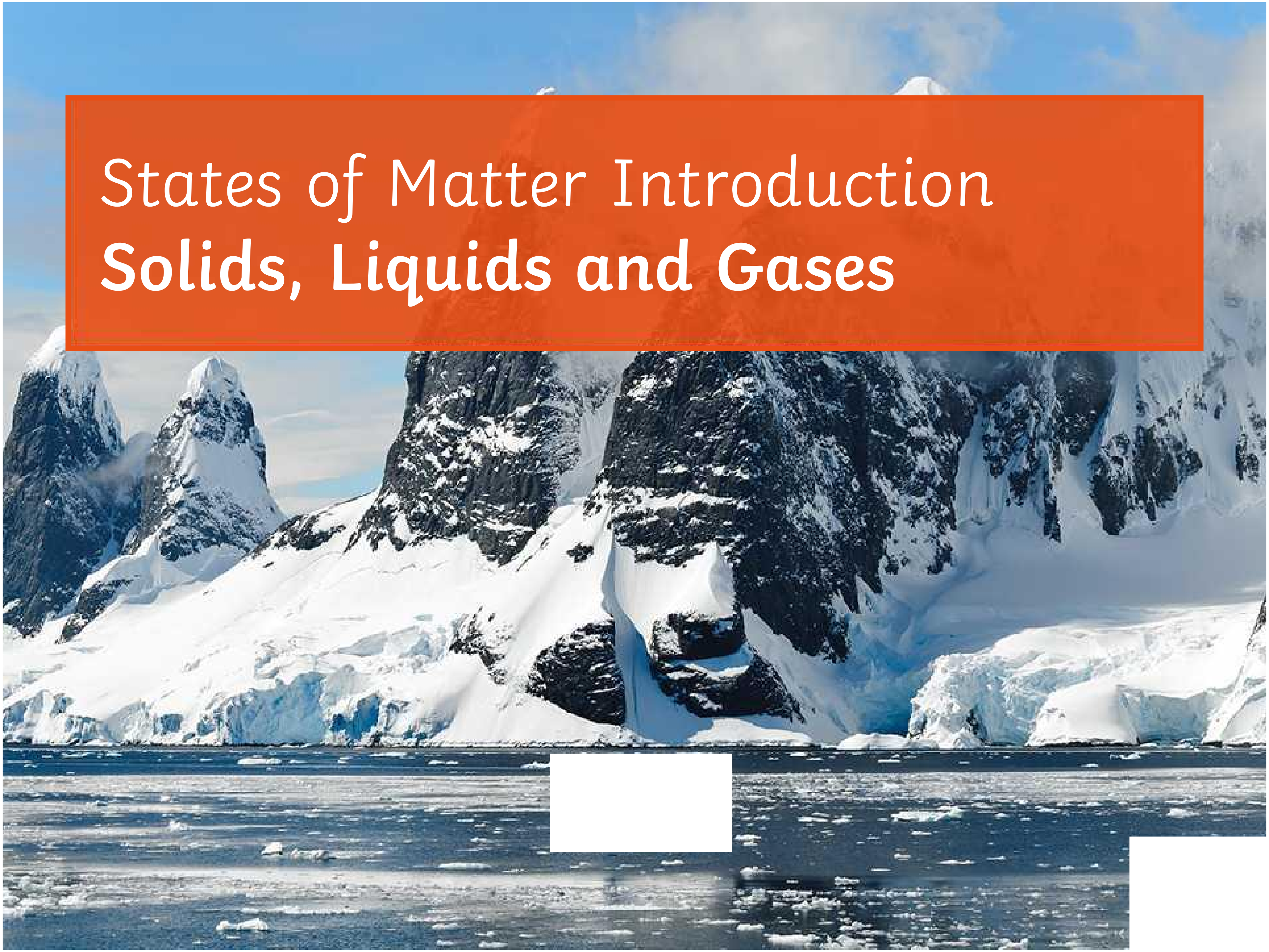
Plenary

Students create a Haiku poem as a mini plenary on shown slides 16-17 of the PowerPoint. Students write in their books a poem about the key points of the three states of matter with five syllables in the first sentence, seven syllables in the second sentence and five syllables in the third and final sentence. Two examples are given on slide 17. Remind the students of today's success criteria on slide 18 of the PowerPoint.

Suggested Home learning:

Students could research and produce a poster on 'Non Newtonian Fluids'.

States of Matter Introduction
Solids, Liquids and Gases



Learning Objective

- To understand that matter can exist in three states.

Success Criteria

- To define matter.
- To state the three states of matter.
- To compare and contrast the three states of matter.

Starter: What Is Matter?

- Everything is made up of matter.
- So what is matter?
- How do we know it exists?

Matter

- Everything is made up of matter.
- Matter is any substance that has **mass** and takes up space (**volume**).
- Your desk is made of matter.
- Your pencil is made of matter.
- You are made of matter!

Matter

There are **five** states of matter.

You will learn about three of these in KS3 Science.

The 3 states of matter you need to know are:

solid

liquid

gas

Identifying Types of Matter

Write the following subheadings in your book with 3-4 lines in between each of them:

Solids in the Classroom

Liquids in the Classroom

Gases in the Classroom

Identifying Types of Matter

Now in pairs you have **two minutes** to look around the classroom and write down as many solids, liquids and gases you can think of!

Time's up!

Identifying Types of Matter

Now in pairs you have **two minutes** to look around the classroom and write down as many solids, liquids and gases you can think of!

Circle one answer that you think no-one else in the class has written down.

Add at least three new answers as you listen to your classmates.

Properties of Types of Matter

What makes a solid different from a liquid, or a gas?

These features are called properties.
(In science this doesn't mean a house!)

For example:
hard, soft, can flow, invisible.

You have already used some properties to successfully identify solids, liquids and gases in the classroom.

Properties of Types of Matter

What makes a solid different from a liquid, or a gas?

Properties of Types of Matter

In small groups you are going to **describe the properties** of the three states of matter: solids, liquids and gases.

Points to include:

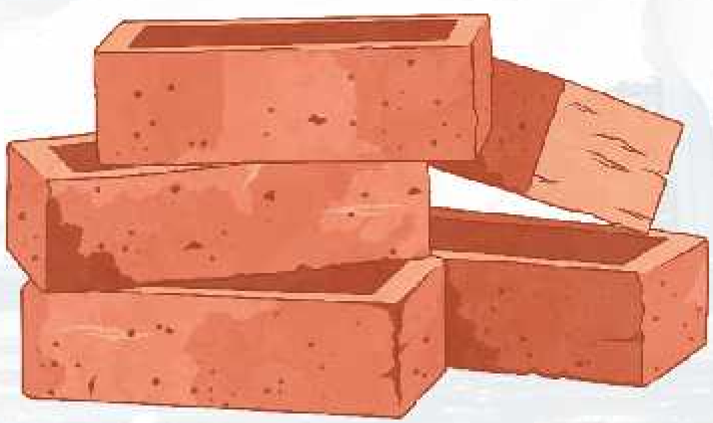
- What does it feel like?
- What does it look like?
- Can you squash it? Pour it?
- Plus anything else you can think of!

Not sure where to start? Imagine you were describing your state of matter to an alien from outer space!

Challenge:
Can you write your description in 20 words or less?

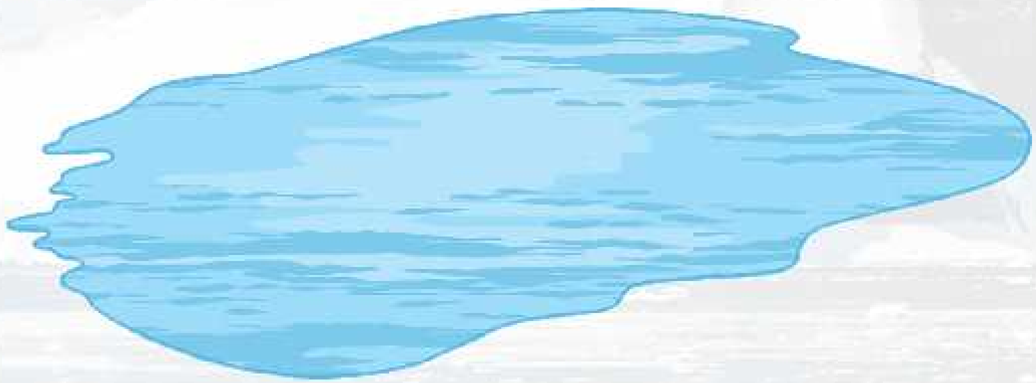
Properties Key Points: Solids

- Have a fixed shape.
- Cannot be squashed (compressed).
- Cannot flow.
- Particles cannot move, but can vibrate on the spot.



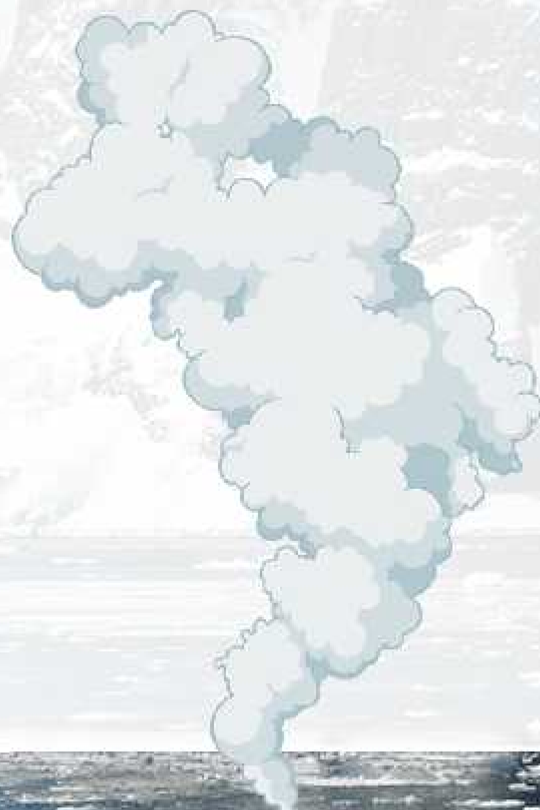
Properties Key Points: Liquids

- No fixed shape - takes the shape of the container.
- Cannot be squashed (compressed).
- Can flow.



Properties Key Points: Gases

- No fixed shape - takes the shape of the container.
- Can be squashed (compressed).
- Can flow.



Plenary: Matter Haikus

Create a haiku about matter or the three states of matter.

Each line of a haiku has a set amount of syllables and there are only three lines in total.

- The first line has **five** syllables.
- The second line has **seven** syllables.
- The third and final line has **five** syllables.

Haiku Examples

To define matter,
Anything with space and volume,
Is matter in life.

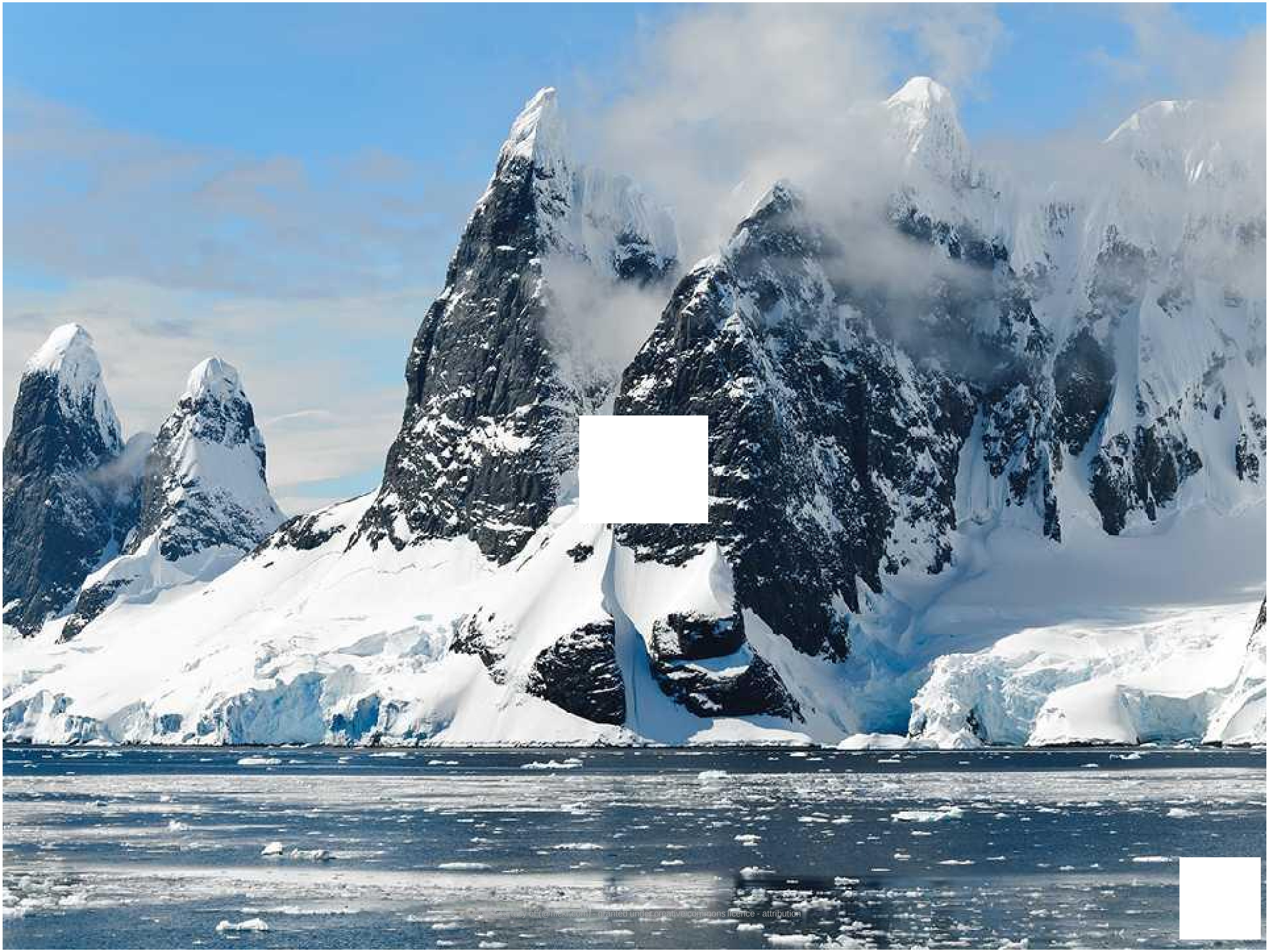
Matter has three states,
Solids, liquids and gases.
With different traits.

What Did You Achieve Today?

I can define matter.

I can state the three types of matter.

I can compare and contrast the three types of matter.


courtesy of (@flickr.com) - granted under creative commons licence - attribution

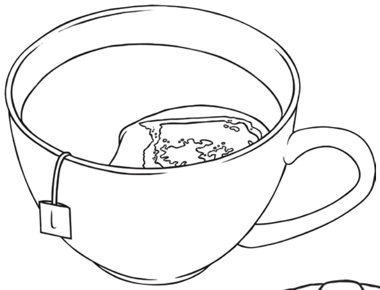
Solids, Liquids and Gases

1. What is matter?

____

____

2. Identify the solids, liquids and gases in the following situations:

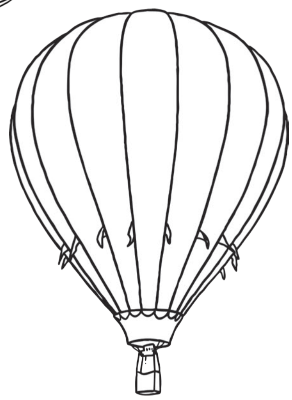


a) Making a cup of tea

Solids: ___________________________

Liquids: ___________________________

Gases: ___________________________



b) A hot air balloon

Solids: ___________________________

Liquids: ___________________________

Gases: ___________________________

3. Properties of Matter

Complete the following table using ticks and crosses:

	Solid	**Liquid**	**Gas**
Has a fixed shape?			
Can be compressed?			
Can it flow?			
Takes the shape of the container it is in?			

Challenge: Can you think of any substances that have properties of both a solid and a liquid?

____

____

Learning Objectives:

- ☐ I can define matter.
- ☐ I can identify solids, liquids and gases in everyday situations.
- ☐ I can compare and contrast properties of solids, liquids and gases.

Solids, Liquids and Gases **Answers**

1) What is matter?

Matter is any substance that has mass and takes up space (volume).

2) Identify the solids, liquids and gases in the following situations:

a) Making a cup of tea

Solids: Tea bag, tea leaves, kettle, sugar, spoon, cup/mug.

Liquids: Water and milk.

Gases: Steam.

b) A hot air balloon

Solids: Balloon fabric (silk), metal frame, wicker basket.

Liquids: Fuel (liquid propane).

Gases: As the fuel is ignited (now gas propane) it reacts with oxygen to form water and carbon dioxide.

3) Properties of Matter

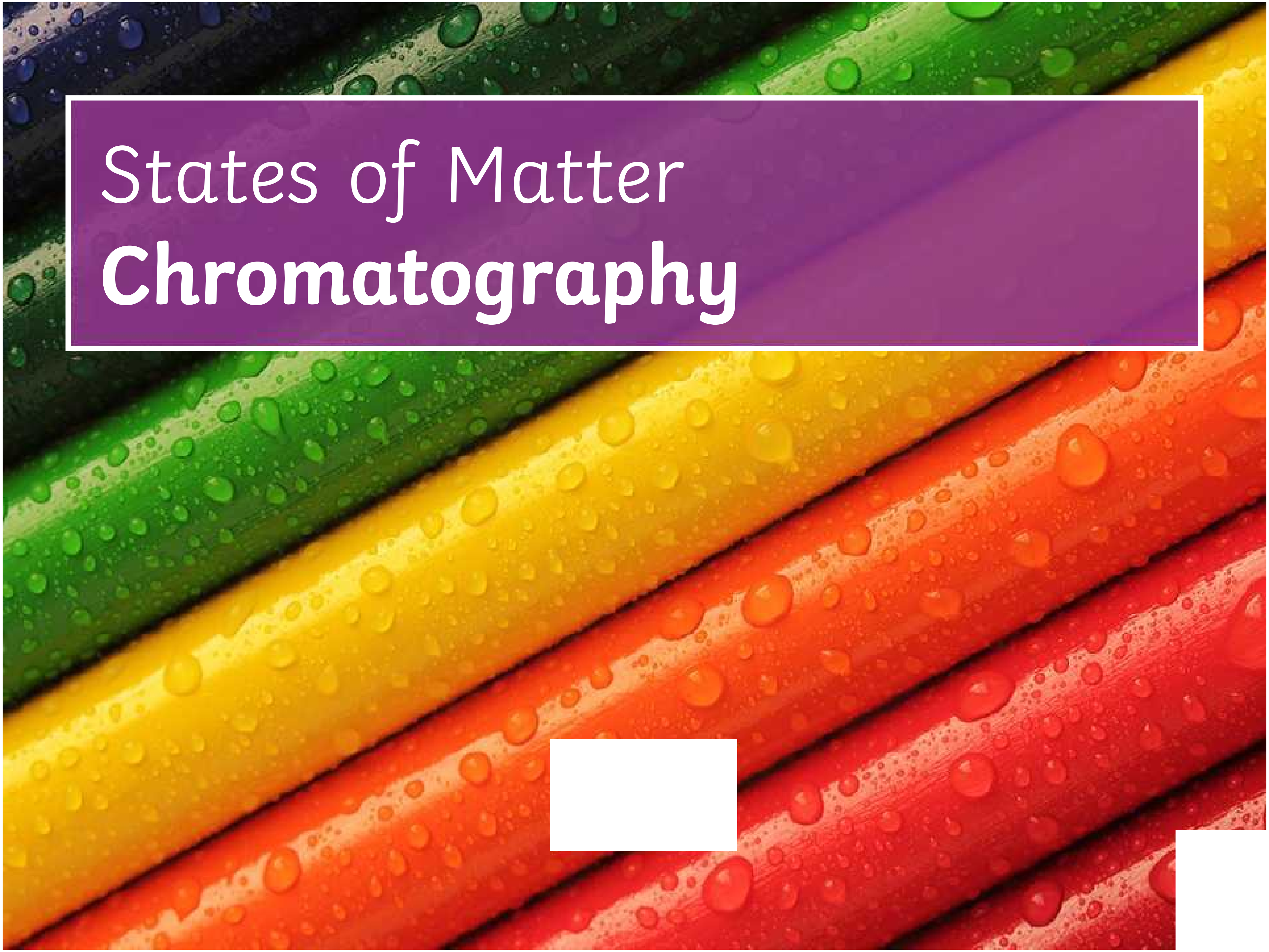
Complete the following table:

	Solid	**Liquid**	**Gas**
Has a fixed shape?	Tick	Cross	Cross
Can be compressed?	Cross	Cross	Tick
Can it flow?	Cross	Tick	Tick
Takes the shape of the container it is in?	Cross	Tick	Tick

Challenge: Can you think of any substances that have properties of both a solid and a liquid?

Toothpaste, tomato ketchup, hair gel etc.

States of Matter
Chromatography



Learning Objective

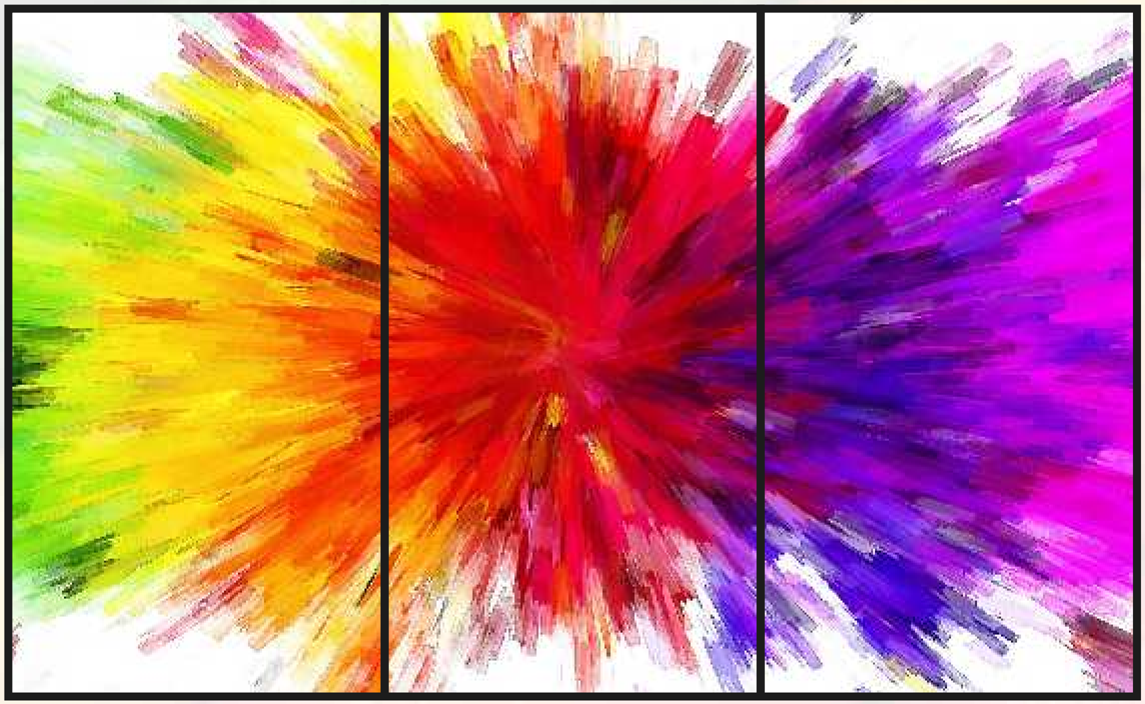
- To understand how to use chromatography as a separation technique.

Success Criteria

- To create a chromatogram.
- To explain how chromatography works.
- To recognise the everyday uses of chromatography.
- To identify different separation techniques.

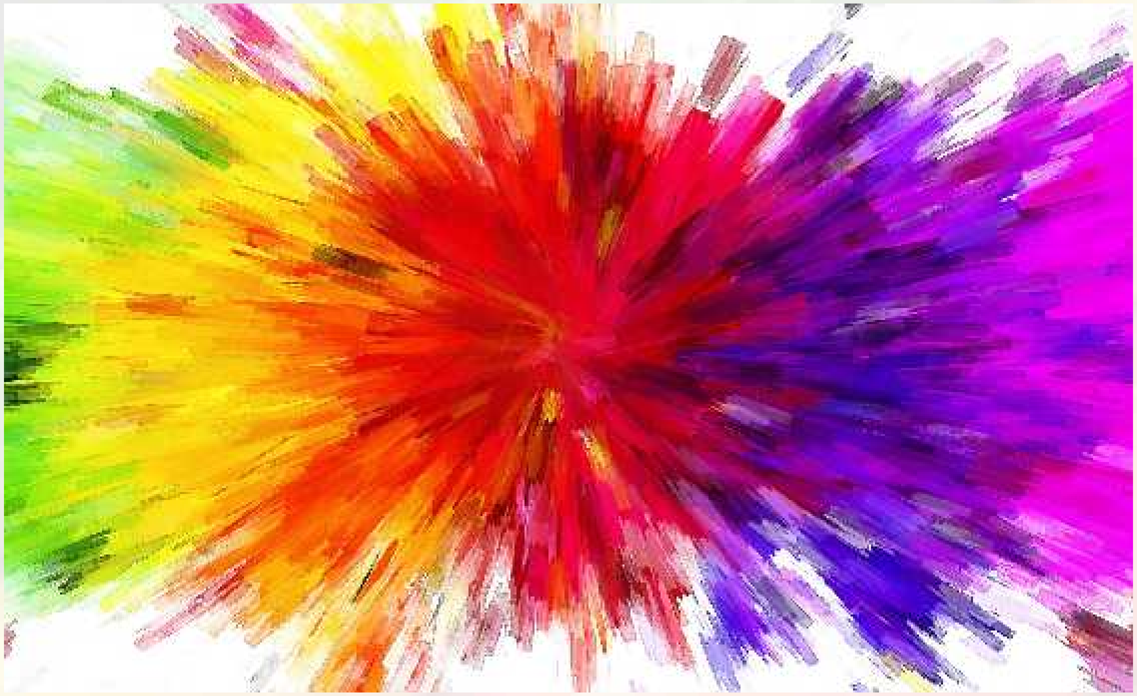
Starter

Choose your favourite section of the picture and write down as many colours as you can see. Be creative with your descriptions!



Challenges: Which primary colours are in your section? Which secondary colours are in your section?

Answers



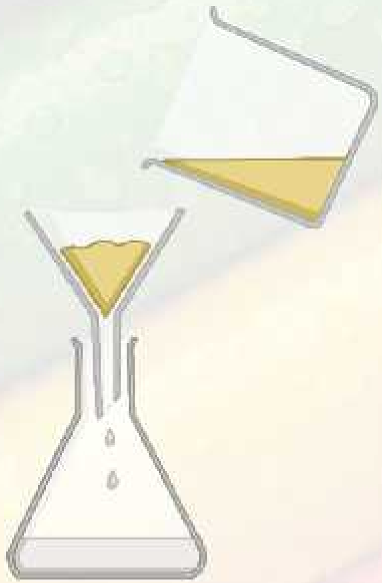
Primary colours are red, blue and yellow.

Secondary colours are orange, purple and green.

Recap

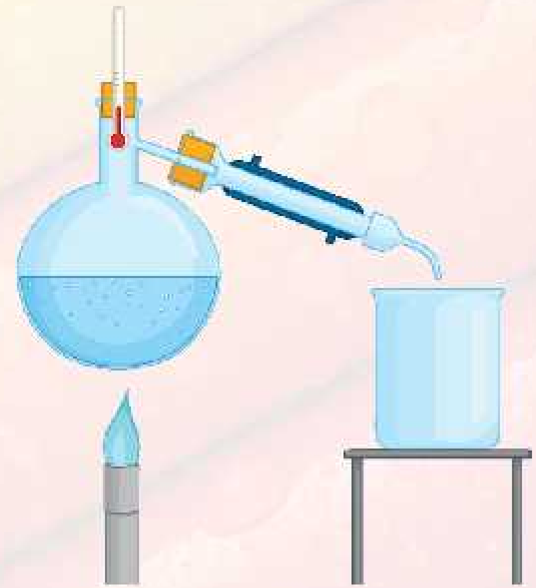
So far we have looked at three **separation techniques**:

filtering



evaporating

distillation

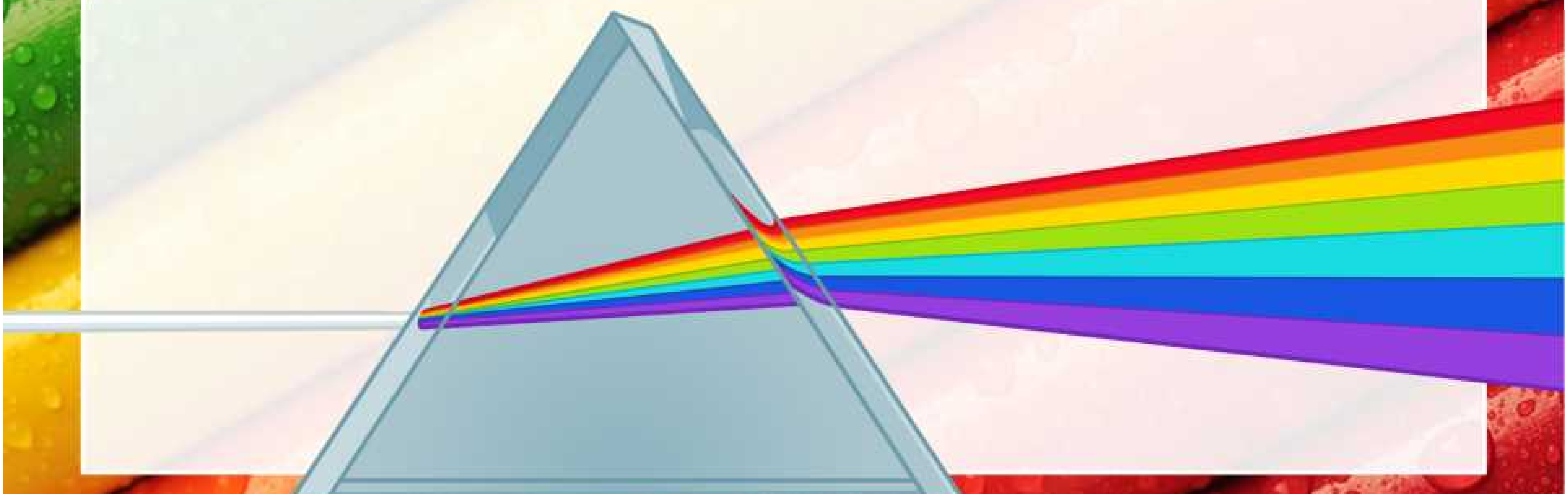


Separation Techniques

Today you will learn a final separation technique called **chromatography**.

‘Chrome’ derives from the Greek word ‘khroma’ for **colour**!

You will **also** use your knowledge of **solubility**.

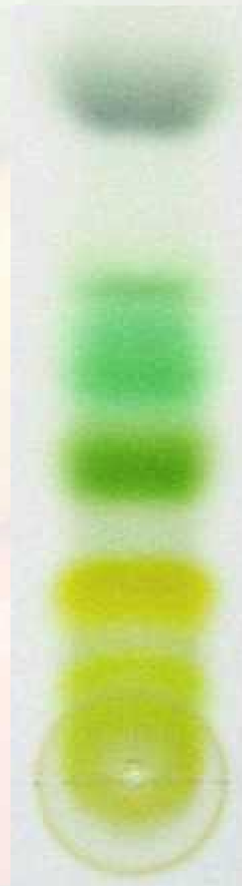


Chromatography

Chromatography separates substances in a mixture.

The technique relies on the substance being **soluble** in a **solvent**.

The term was first used in 1906 when Russian botanist Mikhail Tsvet wrote a paper about producing a colourful pattern of plant pigments!



Carotin

Phaeophytin

Chlorophyll A

Chlorophyll B

Lutein

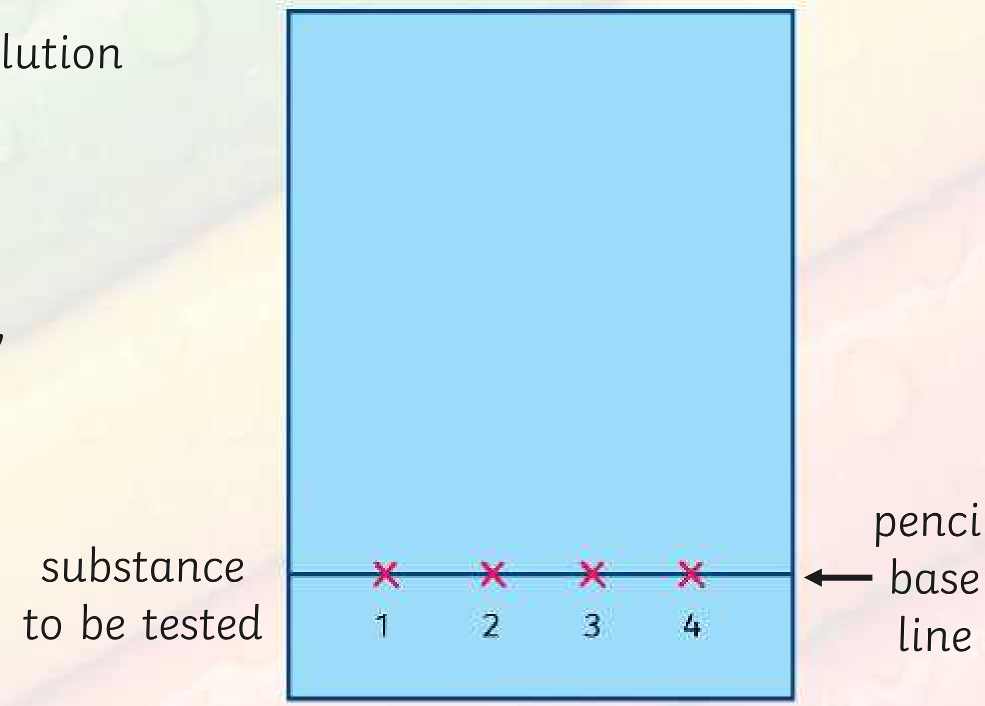
Violaxanthin

Neoxanthin

Chromatography

Step 1: A small amount of solution is placed in a beaker.

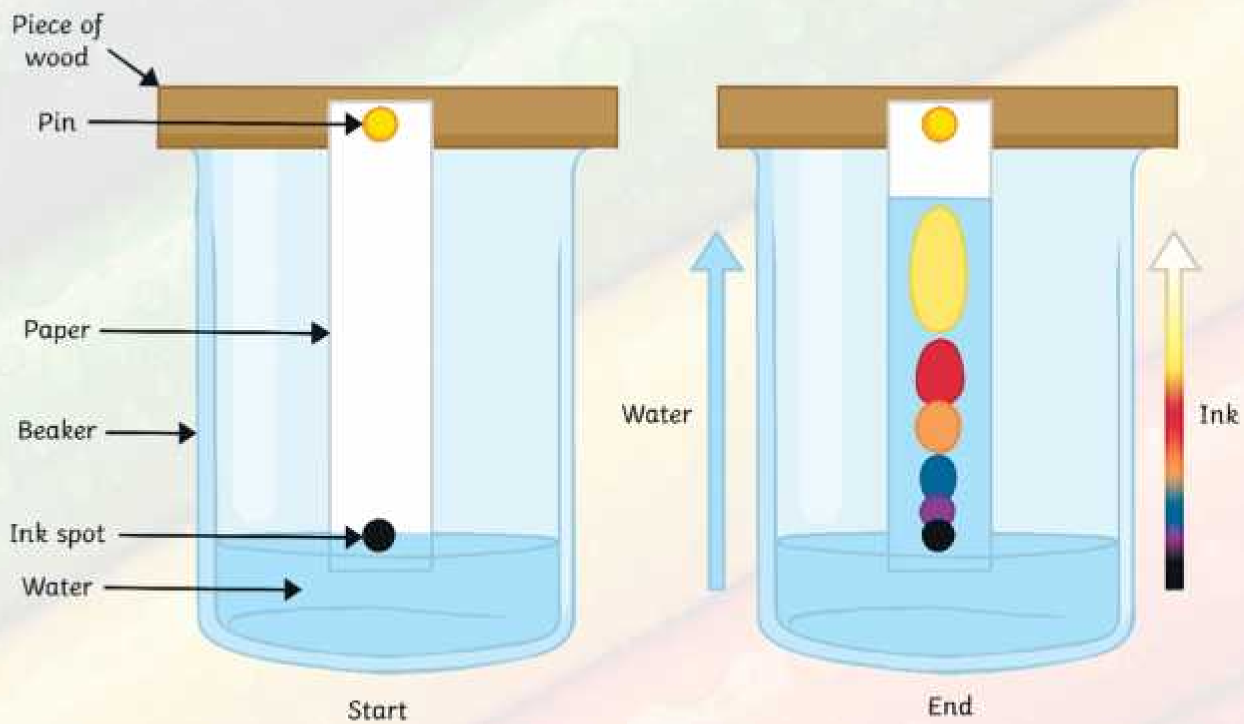
Step 2: On a piece of chromatography/filter paper, a pencil line is drawn.



experiment at start

Step 3: Spots of the substance are placed on the line, spaced apart.

Chromatography



Step 4: The paper is placed into the beaker, with the pencil line at the bottom.

Step 5: The solvent moves up the paper and the dyes begin to separate out.

Step 6: The spots on the chromatogram are analysed and compared.

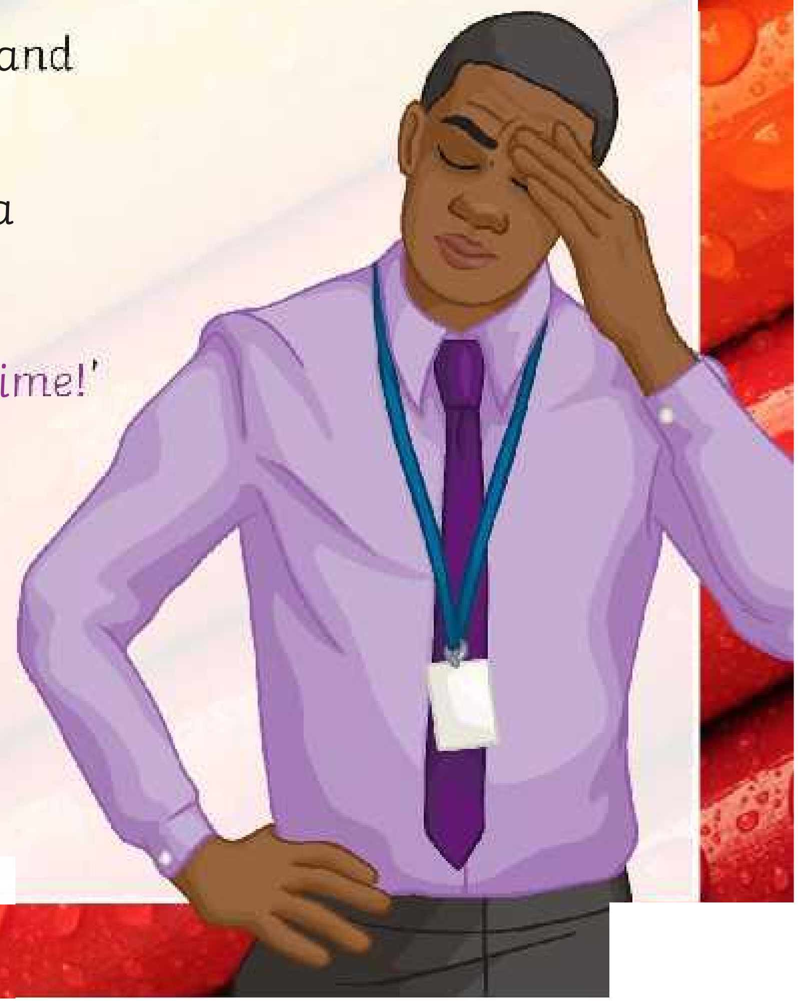
Background

After a busy morning teaching, Mr Rye went to take his sandwich box of out the staffroom fridge.

To his horror, the box was completely empty and his favourite sandwich was missing!

Attached to the top of his sandwich box was a joke written in black pen saying:

'When do astronauts have dinner? At launchtime!'



Background

Mr Rye could only think of three people who would do such a terrible thing - and write such a terrible joke!

He quickly extracted some of the ink from the joke, placed it into a solvent and made a chromatogram.

It looked like this:

Teacher:
Insert photo of pre-prepared chromatogram here.

Chromatography

Follow the **Solving Crimes Using Chromatography** sheet to make a chromatogram and compare it with Mr Rye's to find out who stole the sandwich!

Pen from Suspect A	Pen from Suspect B	Pen from Suspect C
		
Mrs Sourdough	Mr Loafer	Miss Poppyseed

Real World Applications

Discuss in pairs, how might chromatography be used in:

- Crime scene investigations?
- Restoring old paintings?
- Recovering stolen money?
- Food nutrition?

Real World Applications

Crime scene investigations use chromatography to separate out blood samples, ink and even powders from explosions.

Chromatography is very useful in restoring old paintings, as the paint can be separated out to know which substances were used and whether any restoration has already taken place.

Real World Applications

A red dye is often activated and explodes onto on large quantities of money taken from banks. The dye creates a unique chromatogram that can be compared with suspect notes.

Foods can be tested to see if they contain flavour or colour additives. Also to quantify the vitamin content.

Quick Assessment Sheet

Now complete the assessment sheet to show your understanding of today's lesson.

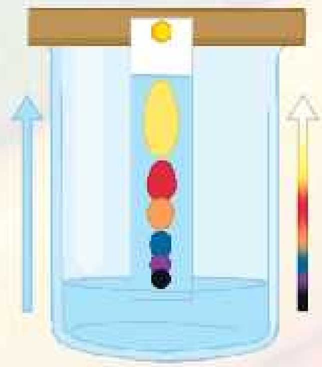
Plenary

1. Name each technique (A to D).

2. Decide which technique you would use to separate the mixtures in each situation (E to H).

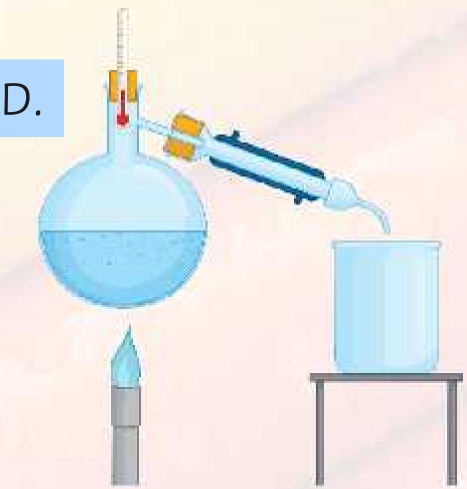
A.

B.



C.

D.



E. Separating salt from water.

F. Separating sand from water.

G. Separating mixtures in crude oil.

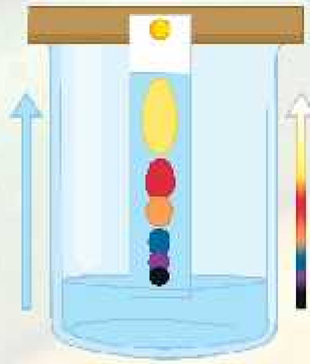
H. Separating food dyes in sweets.

Challenge: Explain why you chose that technique.

Answers Part 1

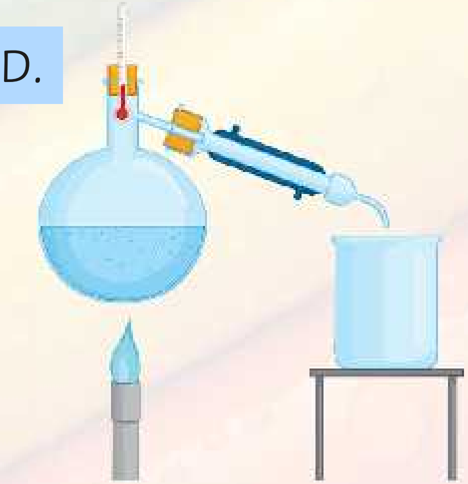
A.

B.



C.

D.



A. Filtering

B. Chromatography

C. Evaporation

D. Distillation

Answers Part 2

E. Separating salt from water.

F. Separating sand from water.

G. Separating mixtures in crude oil.

H. Separating food dyes in sweets.

E. Evaporation

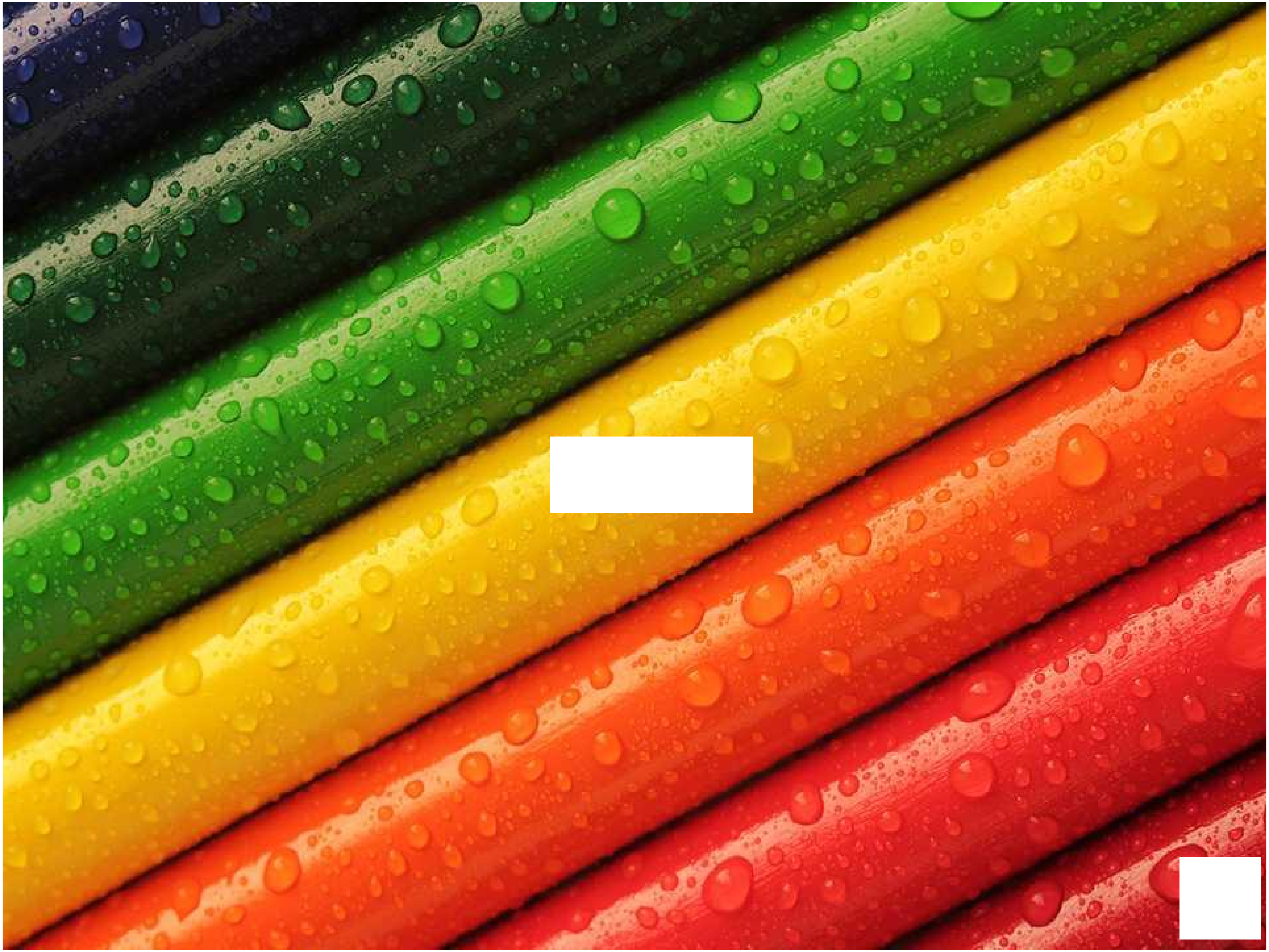
F. Filtering

G. Distillation

H. Chromatography

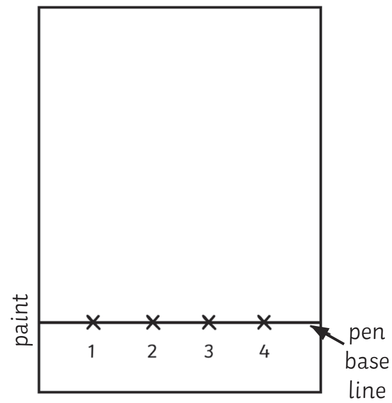
What Did You Achieve Today?

- I can create a chromatogram.
- I can explain how chromatography works.
- I can recognise the everyday uses of chromatography.
- I can identify different separation techniques.



Chromatography **Quick Assessment**

1. Zayan carried out chromatography on the food colourings used in sweets. He set up the chromatography/filter paper as shown.



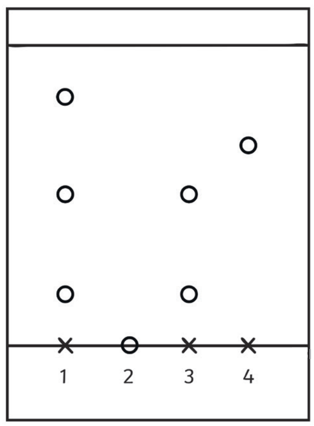
experiment at start

a. State the two solvents that Zayan could have used.

b. Identify one error that Zayan made in the way he set up his paper.

c. Describe the problem this would have caused.

d. Here is Zayan's chromatogram after he rectified his mistake.



How many colourings are found in sweet 1?

e. Explain how the pattern was created using as many keywords as you can.

Learning Objectives:

- ☐ I can identify and apply solubility keywords to chromatography.
- ☐ I can explain how chromatography works.
- ☐ I can analyse a chromatogram.
- ☐ I can apply my knowledge to new situations.

Chromatography Quick Assessment **Answers**

1.

a. State the two solvents that Zayan could have used.

ethanol or rubbing alcohol

b. Identify one error that Zayan made in the way he set up his apparatus.

The (base)line was drawn in pen, not pencil.

c. Describe the problem this would have caused.

The pen use could be soluble and also separate out into different colours. This would make it difficult to identify patterns in the end result caused by the pen or by the sweets.

d. How many colourings are found in sweet 1?

Three - most students will incorrectly include the baseline spot also, but remind them this is a mixture.

e. Explain how the pattern was created using as many keywords as you can.

The food colourings are <u>soluble</u> in the <u>solvent</u> (ethanol). The solvent moves up the paper and comes into contact with the dot of food colouring which is a <u>mixture</u> of substances. The solvent continues to move up the paper, and <u>separates</u> the mixture out. Smaller molecules often move further. The end pattern produced is called a <u>chromatogram</u>.

Chromatography Quick Assessment **Teacher Feedback**

Effort: **1** **2** **3** **4** **5**

With **guidance**, you can identify **one** solvent used in chromatography.	You can **independently** identify **one** solvent used in chromatography.	You can **independently** identify **two** solvents used in chromatography.
With **guidance**, you can identify an error in an experiment.	You can **independently** identify an error in an experiment.	You can **independently** identify an error in an experiment and describe the impact it may have on results.
You can explain chromatography simply, using **some** key words.	You can explain chromatography, using **most** key words.	You can explain chromatography using **all** key words.
With **guidance**, you can analyse a chromatogram.	You can **independently** analyse a chromatogram, with some errors.	You can **independently** analyse a chromatogram correctly.
Overall, with **guidance** you can apply **some** of your knowledge to a new situation.	Overall, you can independently apply **most** of your knowledge and key words to a new situation.	Overall, you can independently apply **all** of your knowledge and key words to a new situation.

Next Steps:

Chromatography
Teaching Ideas

Learning Objective: To understand how to use chromatography as a separation technique.

Success Criteria:

- To create a chromatogram.
- To explain how chromatography works.
- To recognise the everyday uses of chromatography.
- To identify different separation techniques.

Context: This is the tenth and final lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Resources

A pre-made chromatogram using a soluble black pen for the students to compare theirs to. A photo of this may be inserted into the PowerPoint on slide 11.

Chromatography apparatus (per group): chromatography paper cut into small strips, solvent (ethanol ideally, or water), pencils, rulers, glass beakers, glass rods, string/paperclips.

The whole class need access to the same three black pens (for example ballpoint, felt tip and permanent, including the one used to create the pre-made chromatogram).

Starter

As students enter the classroom and settle, on slide 3 is a picture of a 'colour explosion' split into three sections alongside a task asking students to choose their favourite section and list as many colours as they can see, using descriptive language. There are also two challenge questions, asking students to further identify primary and secondary colours in their chosen section. This allows for cross-curricular links to art and also English in terms of using descriptive language. There is an embedded three minute timer. On slide 4, the primary and secondary colours are stated.

Main Activities

Recap and Separation Techniques

Slides 5-6: On slide 5 is a recap about the three separation techniques covered in the topic so far: filtering, evaporating and distillation. On slide 6 is a brief introduction to the lesson and an explanation of the word 'chrome' deriving from the Greek word 'khroma' for colour. The end of slide 6 also informs students that their prior knowledge of solubility will be applied in this lesson.

Chromatography

Slides 7-9: Slide 7 introduces more detail on the technique, using solubility key words to make the links clear to students and also a brief history of chromatography. Slides 8 and 9 go through a six step sequence of how to perform chromatography. This could also be modelled by the teacher simultaneously to show students how to set up and create a chromatogram.

Chromatography Apparatus Activity Sheet

Slide 10-12: Introduce the chromatography mystery for students to solve by showing slides 10-11. Slide 10 details the background story of a teacher's sandwich going missing in the staffroom fridge and a note, written in black ink, being left on the empty sandwich box. Slide 11 then states how the teacher can only think of three people who would commit the crime and that he created a chromatogram by extracting the black ink from the note. As this point, the pre-made chromatogram should be shown to the students and left in a secure place to compare with later. A photo of it can be inserted into the PowerPoint. Slide 12 has boxes with the three suspects' names and spaces for the teacher to affix the pen to the board or have each pen clearly labelled A, B and C. Students then follow the activity sheet to create a chromatogram by following the method. Whilst the chromatogram is being created, there are integrated questions on the first side of the sheet for students to complete. Students should be encouraged to come and compare their chromatogram to the pre-made one and then continue onto the second side of the sheet, answering the analysis style questions.

Chromatography Real World Applications

Slides 13-15: To contextualise the lesson, on slide 13 students are asked to discuss in pairs how chromatography might be used in crime scene investigations, restoring old paintings, recovering stolen money and food nutrition. The answers are briefly described on slides 13 and 14. Knowledge of gas chromatography as opposed to paper chromatography is not required at this key stage, but could be discussed if appropriate.

Chromatography Quick Assessment Sheet

Slide 16: Students follow the worksheet to demonstrate their knowledge of chromatography by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Slides 17-20: Students work in pairs to identify the for separation techniques as shown in the pictures (A to D). Students must then decide which technique to use in each situation described, to separate out the mixture. There is also a challenge question asking students to explain why they chose that technique to justify their answers. Slide 18 shows the answers to the first part of the plenary, identifying the techniques A to D. Slide 19 shows the answers to the second part of the plenary, matching the technique to the situations E to H. Remind the students of today's success criteria on slide 20 of the PowerPoint.

Suggested Home Learning

If resources permit, students could be given a piece of chromatography paper and asked to make a piece of art using felt tips and water at home. These can then be rewarded, laminated and displayed. Alternatively, students could complete the **Chromatography Quick Assessment Sheet** if not completed during class time.

Solving Crimes Using Chromatography

Aim: To make and analyse a chromatogram to solve who stole Mr Rye's sandwich from the fridge!

1. Follow the method to make a chromatogram:

a. Collect a strip of chromatography paper.

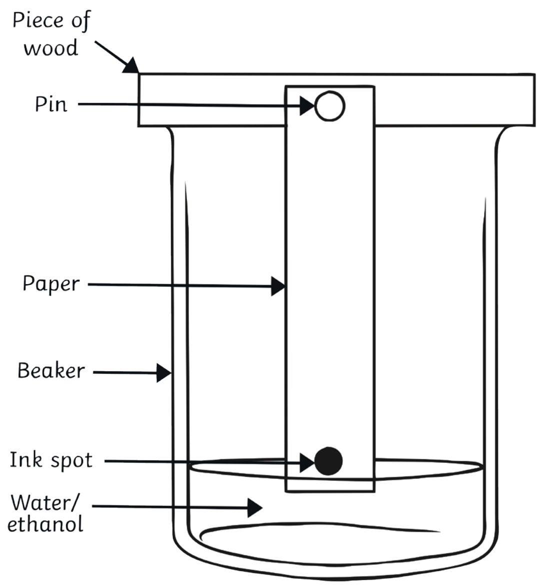
b. Draw a pencil line approximately 1.5cm from the bottom.

c. Place a small dot of suspect A's black pen ink on the line, slightly in from the edge.

d. Leave a 0.5cm gap, and then place a small dot of suspect B's black pen ink on the line.

e. Leave a 0.5cm gap, and then place a small dot of suspect C's black pen ink on the line.

f. Roll the other edge around a pencil or glass rod and safely secure it.



g. Place a small amount of solvent (ethanol or water) in a glass beaker.

h. Place the paper into a beaker, placing the pencil or glass rod over the top of the beaker.

Tip: Make sure your filter paper touches the solvent, but the pencil line is above the solvent, and make sure the paper doesn't curl up or fall in.

2. Whilst you are waiting for your chromatogram to form, answer the following questions:

a. I think the suspect is: ____________________

b. Complete the gap fill. Either use the words underneath, or cover them up as a challenge!

Chromatography works because the ink is a ____________________ of substances and can be separated out, using a physical method. The liquid in the beaker is the ____________________ and the pen dissolves in this, so we say it is ____________________. Different substances travel through the paper at different rates. Usually smaller molecules travel ____________________ along the paper than larger ones. The pattern created is called a ____________________ and can be compared with known substances.

Words to use: **soluble, mixture, further, chromatogram, solvent.**

c. Why did you draw the line at the bottom in pencil, not pen?

____

____

____

3. Once your chromatogram is dry, glue it in the box on the right.

4. Compare your chromatogram to Mr Rye's. Who stole his sandwich?

The teacher who stole the sandwich was: ____________________________

5. How do you know this?

____

____

____

6. List all of the colours can you see in your chromatogram:

____

____

____

7. What surprised you most about this practical?

____

____

____

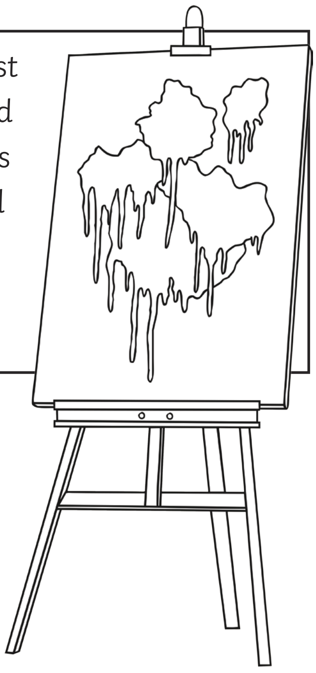
8. If you could repeat this practical, what might you do differently next time?

____

____

____

Did you know? Chromatography can make amazing pieces of art, but one artist has taken it one step further! Anicka Yi is a conceptual artist who has enlisted scientists to use chromatography in order to separate out the chemical compounds in sweat. These compounds are then made into a scent by an experienced perfumer and emitted throughout the gallery, alongside her sculptures made of live bacteria! Anicka says, 'I've always maintained that scientists and artists have a lot in common. There's a lot of experimenting - and failure - involved.'



Solving Crimes Using Chromatography **Answers**

Whilst you are waiting for your chromatogram to form, answer the following questions:

a. I think the suspect is: **Students answers will vary.**

b. Complete the gap fill. Either use the words underneath, or cover them up as a challenge!

Chromatography works because the ink is a **mixture** of substances and can be separated out, using a physical method. The liquid in the beaker is the **solvent** and the pen dissolves in this, so we say it is **soluble**. Different substances travel through the paper at different rates. Usually smaller molecules travel **further** along the paper than larger ones. The pattern created is called a **chromatogram** and can be compared with known substances.

c. Why did you draw the line at the bottom in pencil, not pen?

The ink from the pen may run and separate out, making it difficult to identify patterns in the end result.

4. Compare your chromatogram to Mr Rye's. Who stole his sandwich?

The teacher who stole the sandwich was: Answers will depend on the pen used by the teacher to create Mr Rye's chromatogram.

5. How do you know this?

The pattern matches Mr Rye's spots or colours in the same places.

6. List all of the colours can you see in your chromatogram:

Students' answers will vary. Common colours observed are red, orange, yellow, green and blue.

7. What surprised you most about this practical?

Students' answers will vary. A common observation is the surprise at the variety of colours contained in black ink and the simplicity of the practical.

8. If you could repeat this practical, what might you do differently next time?

Students' answers will vary. A common extension activity is to try several different coloured felt tip pens, especially secondary colours to separate the inks out.

Particle Model Quick Assessment

1) For each property, explain why it is possible in terms of how the particles are arranged:

a. Solids and liquids cannot be compressed (squashed).

b. Liquids and gases can flow.

c. Gases can be compressed.

2) Mercury is a metal but is a liquid at room temperature. Describe the arrangement of the particles of mercury as a liquid, compared to at −38°C when it becomes a solid. **Challenge:** try to refer to 'density' and 'forces' in your answer.

3) Why do scientists use models?

4) We used an analogy (a comparison) for density comparing the idea to packing lots of clothes into a suitcase. Can you think of two other analogies for density?

Learning Objectives:

- ☐ I can link the arrangement of particles in each state of matter to their properties.
- ☐ I can describe the arrangement of particles in liquids compared to solids.
- ☐ I can compare density to everyday situations as an analogy.

Particle Model Quick Assessment **Answers**

1)

a. Solids and liquids cannot be compressed (squashed) because there are no spaces between the particles, so we say they are very dense/have a high density.

b. Liquids and gases can flow because the particles are free to move/have no fixed point and so can move over one another.

c. Gases can be compressed because the particles have large spaces between them and move around. They will take the shape of any container they are placed in.

2) Mercury, as a liquid, has particles that are free to move and flow. The forces between the particles are relatively strong, and mercury as a liquid has a high density. At –38°c when mercury becomes a solid, the forces between the particles are stronger. The particles are also regularly arranged and are not free to move/they are fixed, but can vibrate on the spot; there are many particles in a small volume, it has a high density.

3) Scientists use models to help describe and explain phenomena that are difficult to observe. For example, atoms are difficult to see with the naked eye. The particle model is a shared concept between scientists across the world and can help to understand what is happening at a smaller level, but it does have its limitations.

4) Student responses may vary, but could include:

- Several people tightly packed on a mode of public transport during rush hour, compared to the middle of the day.
- Several people entering a cinema, as the film begins to start.
- Students going to the canteen at break time/lunchtime and sitting down to eat, compared to other times of the day.

Note: Try to keep student's responses in the same place, so the volume is kept the same. This will be helpful for them to remember that volume is a key factor in density and in this analogy they are only changing 'mass'.

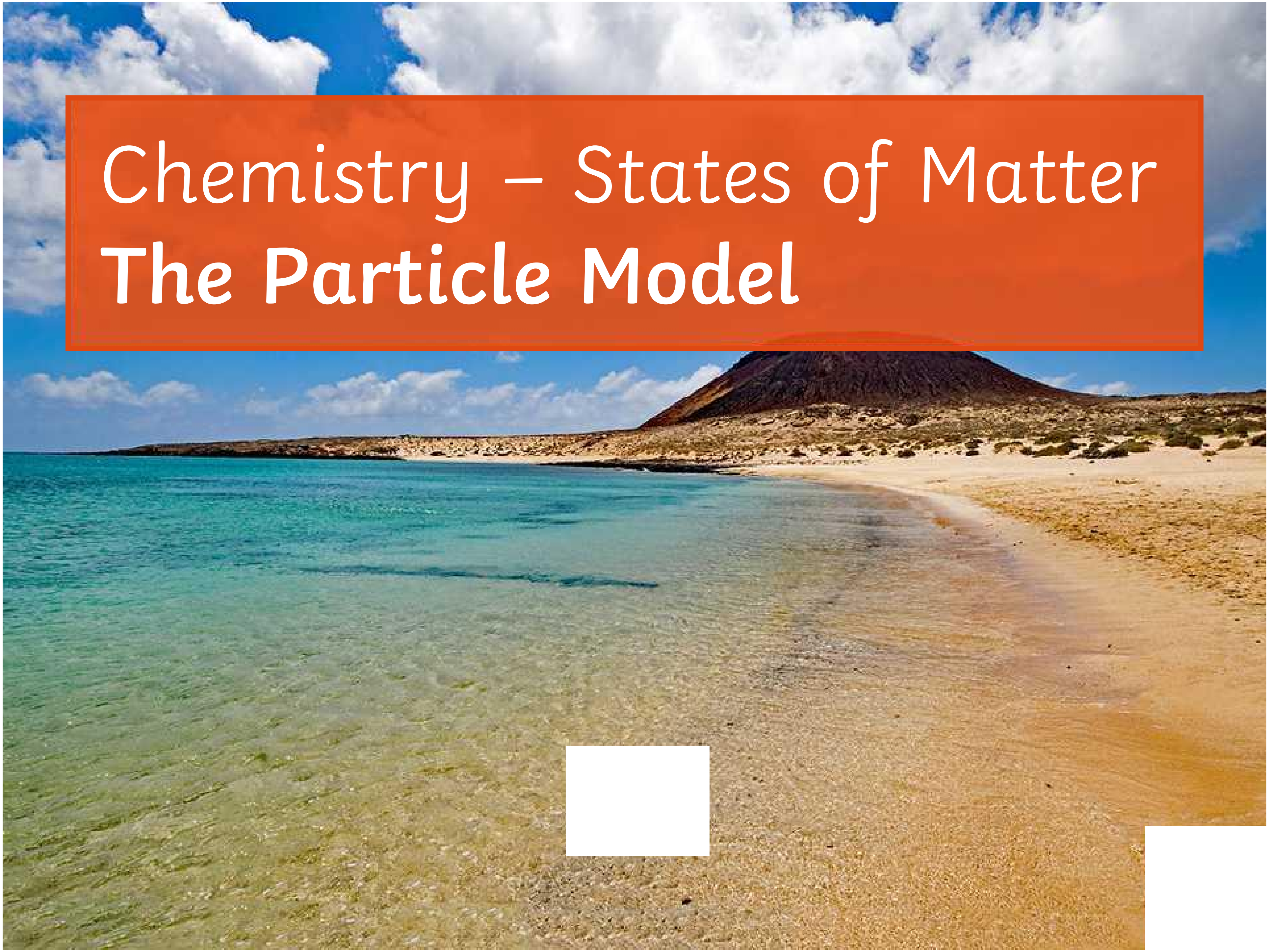
Particle Model Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can link the arrangement of particles in **some** states of matter to their properties.	You can link the arrangement of particles in **most** states of matter to their properties.	You can link the arrangement of particles in **all** states of matter to their properties.
You can describe the arrangement of particles in liquids compared to solids.	You can describe the arrangement of particles in liquids compared to solids and refer to forces or density.	You can describe the arrangement of particles in liquids compared to solids and refer to forces and density.
With guidance, you can compare density to one everyday situation as an analogy.	You can independently compare density to everyday situations as an analogy.	You can compare density to everyday situations as an analogy and refer to mass and volume.

Next Steps:

Chemistry – States of Matter
The Particle Model



Learning Objective

- To understand how particles are arranged in the three states of matter.

Success Criteria

- To identify the arrangement of particles in each state of matter.
- To define density.
- To link the arrangement of particles in each state of matter to their properties.

Starter

Can you identify any states of matter in this picture?

Recap: Matter Key Points

Everything is made up of matter.

Matter is any substance that has **mass** and takes up space (**volume**).

The three states of matter you will learn about in Key Stage 3 Science are:

- solids
- liquids
- gases

Matter Key Points: Zooming In

If we were to 'zoom in' to solids, liquids and gases they would all look different.

To make it easier, we use **small circles** to represent all molecules or atoms as matter.

These small circles of matter are often called **particles**.

Arranging Particles: Thinking Activity

In pairs you have **two minutes** to use the equipment from your pencil cases to represent how you **think** the particles are arranged in solids, liquids and gases!

Take a handful of pens and pretend they are particles and arrange them how you think particles would look like in a solid.

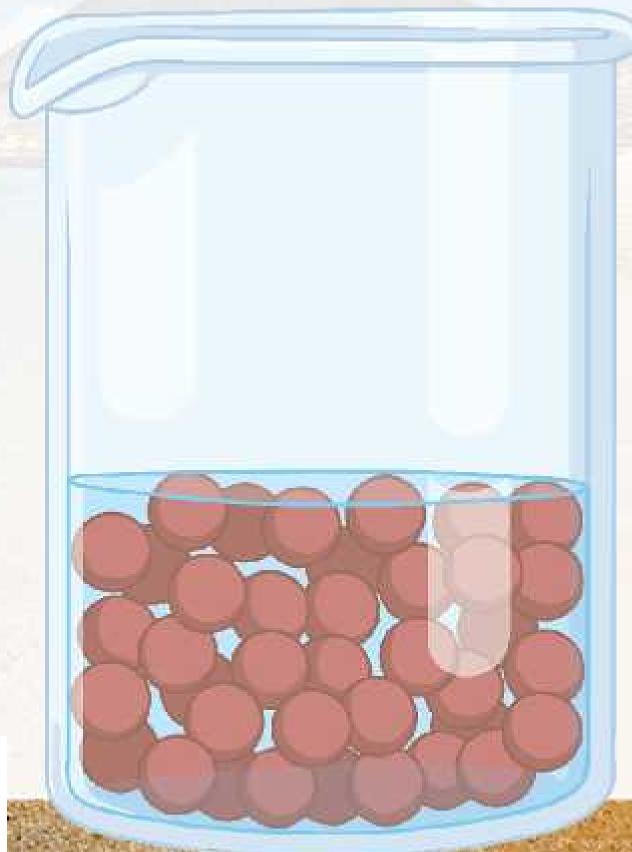
Then, a few centimetres away, repeat this process with liquids and gases.

Time's up!

How Particles Are Arranged

The History of the Particle Model

- Scientists use models to help show ideas more clearly.
- In the particle model, we use circles to represent all types of matter.
- The particle model is also a theory.
- Scientists have been developing, testing and revising this theory for over 2,000 years.



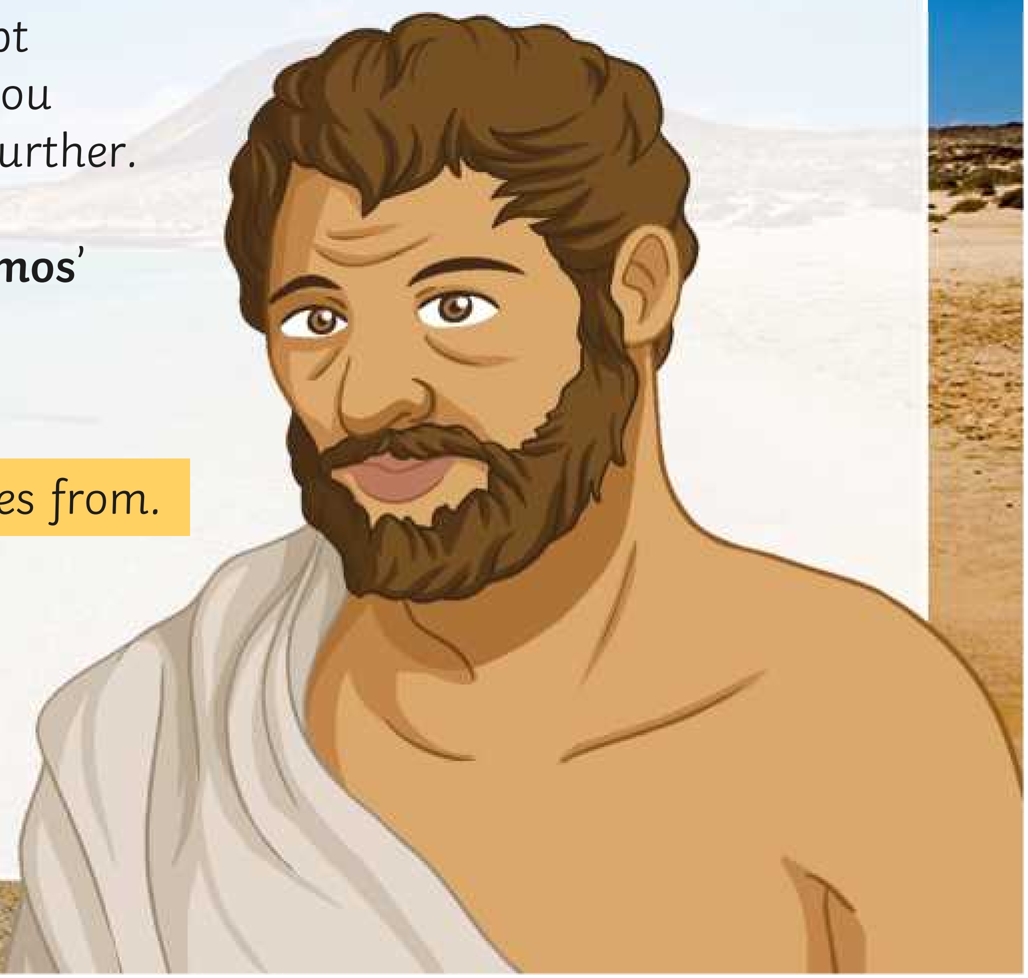
The History of the Particle Model

Democritus was a Greek philosopher who was the first person to realise that all matter is made of particles, over 2,400 years ago!

Democritus thought that if you kept cutting up matter, at some point you wouldn't be able to cut up it any further.

He named these tiny particles '**atomos**' which is Greek for 'indivisible'.

This is where the word 'atom' comes from.

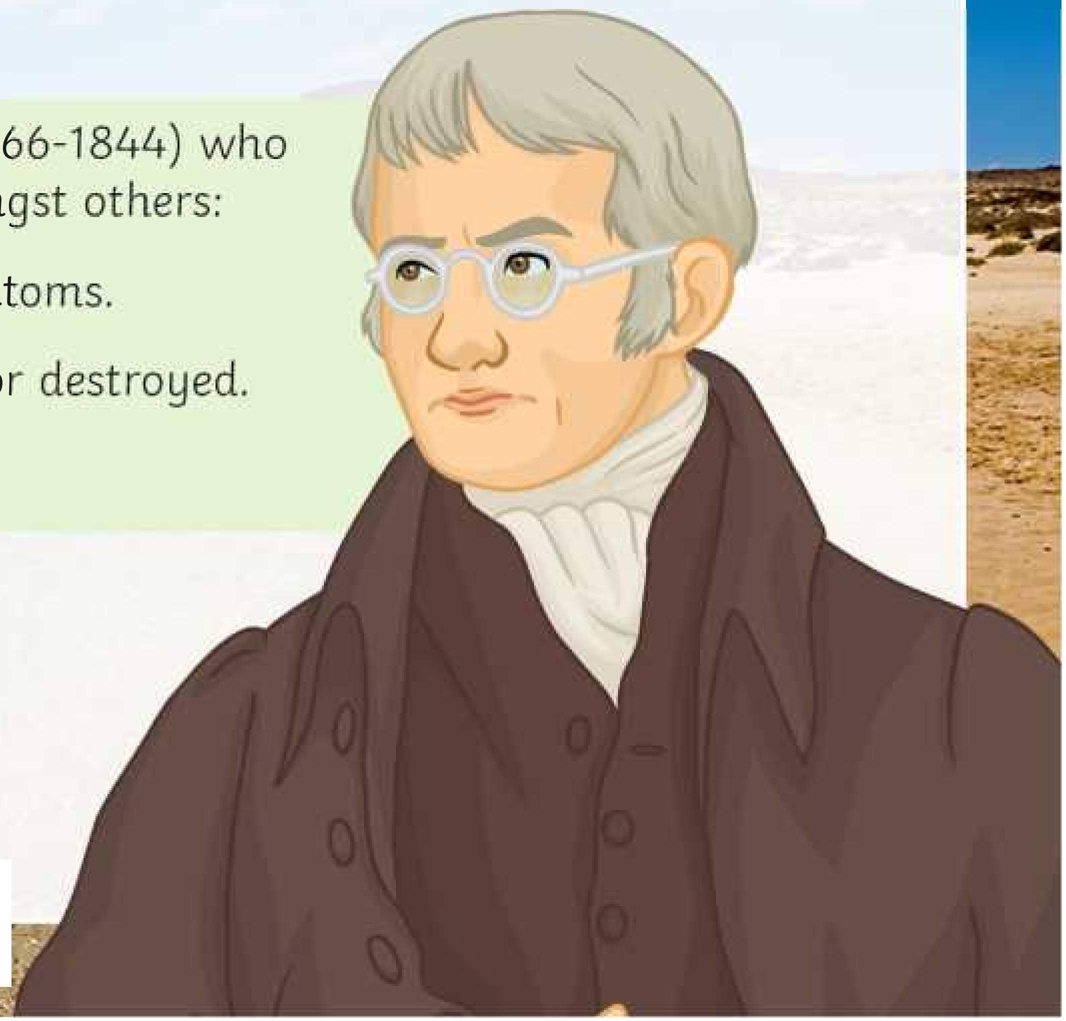


The History of the Particle Model

Since Democritus, several scientists have researched into atoms.

They include John Dalton (1766-1844) who concluded these points, amongst others:

- All matter is made up of atoms.
- Atoms cannot be created or destroyed.
- Atoms cannot be split.



Density Key Points

Density can be defined as the mass of a substance per volume.

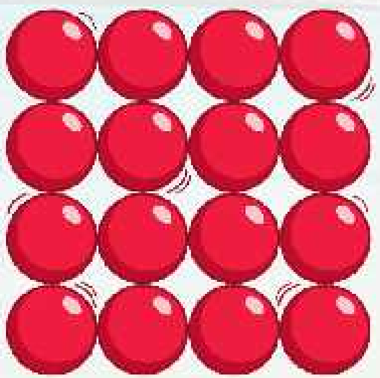
For example: When packing your suitcase how many belongings you take (**mass**) and squash into your suitcase (**volume**)!

Do you think the suitcase in the picture has a **high** or **low** density?

Density Key Points

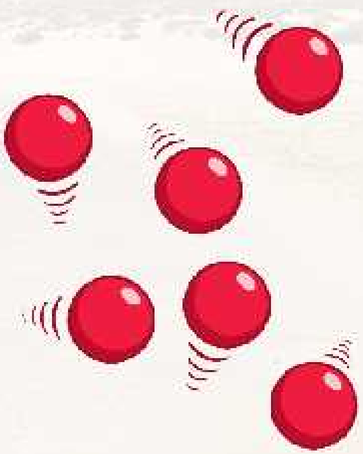
Density is the mass of a substance per volume.

In solids, the particles have a high density.



In liquids, the particles are fractionally less dense than a solid.

In gases, the particles have a low density.



Analogy Activity: ...is like... because...

Write a sentence in your book to say which state of matter each picture represents.

E.g. Sitting in assembly is like a **solid** because...

Challenge 1:
Add some of your own examples.

Challenge 2:
Can you use the word **density** in your explanation?

Example Responses

Sitting in assembly is like a **solid** because the particles are **densely** packed and are regularly arranged.

Playing hockey is like a **gas** because the particles are less **densely** packed and are moving around quickly.

Moving in the corridor is like a **liquid** because the particles are more **densely** packed than a gas and are moving around in small groups.

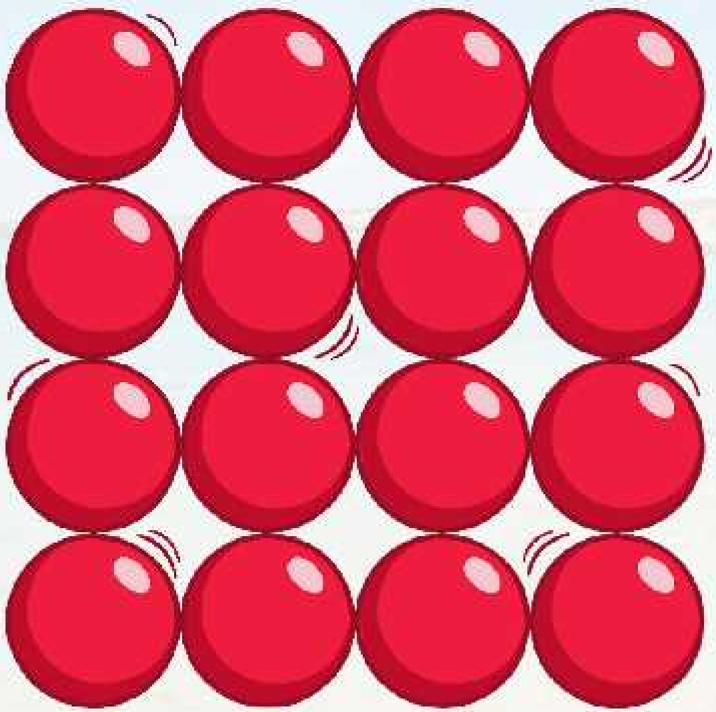
Particle Model Key Points

How particles are arranged in solids, liquids and gases gives them certain **properties**.

In this situation, **properties** are characteristics or features, not houses or buildings!

Properties of a Solid

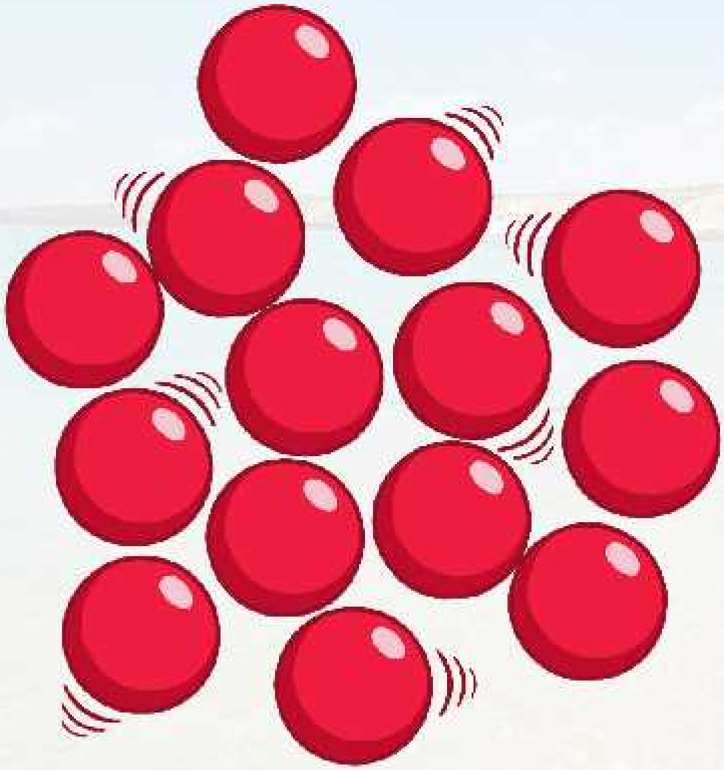
In a solid, the particles are tightly packed, so we say solids have a high density. Because of this, they cannot be squashed (compressed).



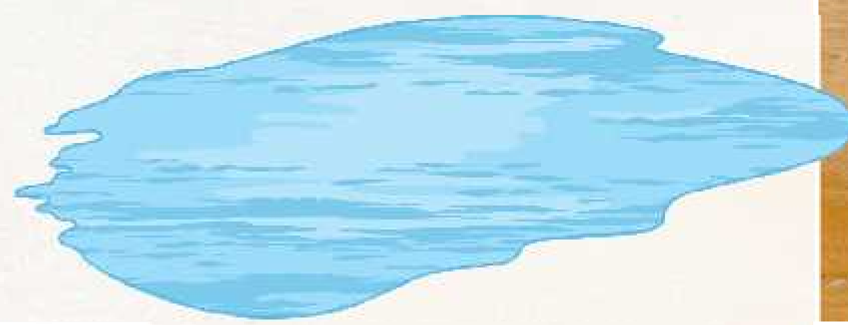
The particles in solids also cannot move around; they are fixed. **The forces are strong between the particles**, they cannot flow or be poured.

Properties of a Liquid

In a liquid, the particles are still close together; as a result they cannot be squashed (compressed).



The particles in liquids **can** move around; they are not fixed. **The forces are weaker between the particles**. They **can** flow or be poured.



Properties of a Gas

In a gas, the particles are spaced apart; as a result they **can** be squashed (compressed).

The particles in gases **can** also move around in all directions; they are not fixed. **The forces are extremely weak between the particles**. They **can** flow or be poured.

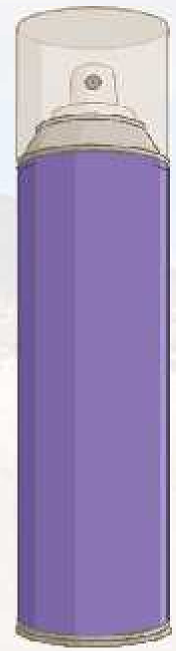
Gas Pressure Key Points

In a gas, the particles are spaced apart. However we often want to use or transport gases. So, we place them in a container and **compress** them.

As the gas particles rapidly move around, they **collide** with the walls of the container. This causes **gas pressure**.

Gas Pressure Key Points

If the **temperature** is increased, the gas particles gain more energy (**kinetic energy**) and so they **collide more often** and **harder** with the walls of the container.



This causes the gas pressure to increase.

- Why can this be very dangerous?
- Have you seen any warning signs anywhere?

'Lift Off' Plenary

3 keywords

2 facts

1 question

What Did You Achieve Today?

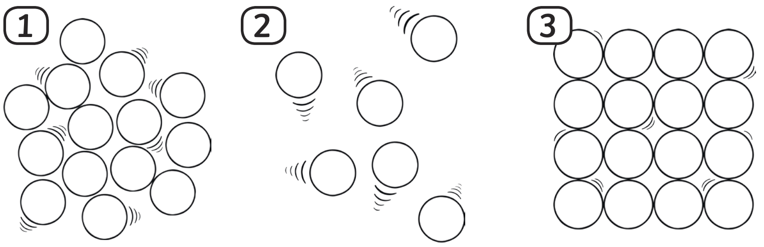
I can identify and describe the arrangement of particles in each state of matter.

I can define density.

I can link the arrangement of particles in each state of matter to their properties.

The Particle Model

1) Match up the picture to the correct state of matter:



Solid

Liquid

Gas

2) Next to each statement write whether it is true (T) or false (F):

a. In a solid, the particles are close together. _

b. Liquids can be squashed (compressed). _

c. Solids, liquids and gases can all be poured, and flow. _

d. The particles in a gas are free to move around in all directions. _

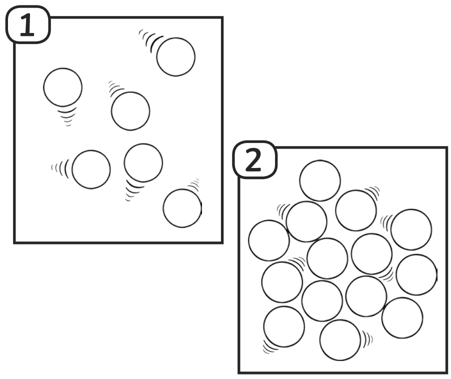
e. Solids and liquids are dense – they have a lot of particles in a small volume. _

f. Gases can be squashed (compressed) easily because they have spaces between the particles. _

3) Density

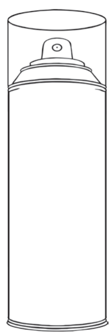
a. Which picture has the highest density (mass per volume)? _

b. Which picture has the lowest density (mass per volume)? _

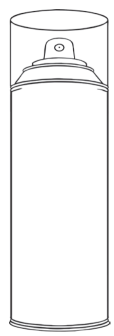


4) Phoebe leaves a can of hairspray on the windowsill on a sunny day. Draw what is happening inside the container in terms of the particles in the morning compared to midday:

Morning:



Midday:



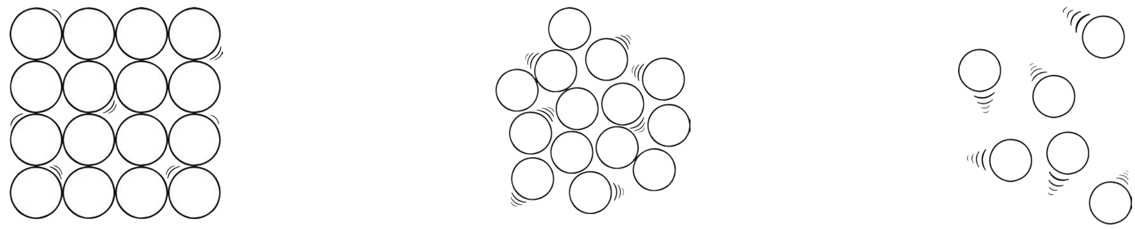
Challenge: Racing car tyres are not inflated to the correct pressure before a race. Why?
Hint: Think about what happens during the race.

Learning Objectives:

- ☐ I can identify the arrangement of particles in solids, liquids and gases.
- ☐ I can identify the properties of solids, liquids and gases.
- ☐ I can compare densities in solids, liquids and gases.
- ☐ I can show how temperature affect gas pressure as a diagram.

The Particle Model **Answers**

1)



solids liquids gases

2) **a. True**

b. False

c. False

d. True

e. True

f. True

3) Density

a) Which picture has the highest density (mass per volume)? **Liquid picture number 1**

b) Which picture has the lowest density (mass per volume)? **Gas picture number 2**

4) Morning: **Student should draw the particles as being far apart, in motion and colliding with the walls of the hairspray can.**

Midday: **There should be a noticeable increase in the movement of the particles and more colliding with the walls of the hairspray can.**

Challenge: Racing car tyres are not inflated to the correct pressure before a race. Why? Hint: Think about what happens during the race?

As the racing car moves around the track, the tyres get warm (friction). This gives the gas particles inside of the tyre more kinetic energy. Therefore the gas particles collide more frequently and with more force against the walls of the tyre. If the tyres were inflated fully, then gained more kinetic energy it could cause the tyre to explode and burst.

The Particle Model

1) What is density?

2) In each box draw how the particles are arranged in solids, liquids and gases:

solids	liquids	gases

3) Explain each property in terms of how the particles are arranged:

a) Gases and liquids can flow and be poured because...

b) Solids and liquids cannot be squashed (compressed) because...

c) Solids cannot flow because...

d) Gases can be squashed (compressed) because...

4) Phoebe leaves a can of hairspray on the windowsill on a sunny day. Describe what is happening inside the can in terms of the particles:

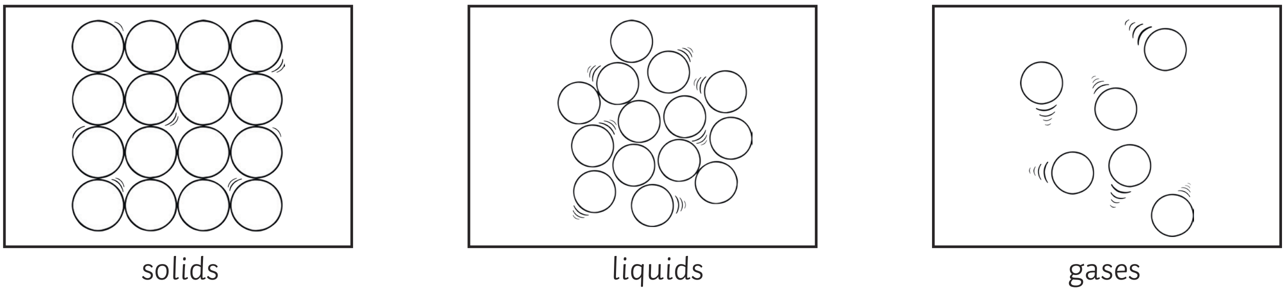
Challenge: Why are drivers encouraged to check their car tyre pressures before completing a long journey?

Learning Objectives:

- [ ] I can define density.
- [ ] I can draw the arrangement of particles in solids, liquids and gases.
- [ ] I can link the properties of solids, liquids and gases to the arrangement of their particles.
- [ ] I can describe the effects of gas pressure.

The Particle Model **Answers**

1) The mass of a substance per unit of volume.



3) a) Gases and liquids can flow and be poured because...

The particles can move around one another and are not fixed. This is because the forces between particles in a liquid are weaker than a solid and weakest in gases.

b) Solids and liquids cannot be squashed (compressed) because...

The particles are tightly packed in a solid and have no spaces in between them, they are very dense. In a liquid, the particles are still closely packed together and are quite dense.

c) Solids cannot flow because...

The particles are fixed and cannot move. But they can vibrate / move around a fixed spot. They have a fixed shape and volume.

d) Gases can be squashed (compressed) because...

The particles are far apart and have spaces between them. The forces between particles in a gas are very weak.

4) Phoebe leaves a can of hairspray on the windowsill on a sunny day. Describe what is happening inside the container in terms of the particles:

Gas particles are always moving and colliding with the walls of the container. As the temperature is increased due to the sunshine, the gas particles gain more kinetic (movement) energy. This means they collide more frequently and harder with the walls of the container. This causes the gas pressure to increase which could lead to the container exploding.

Challenge:

The tyres will warm up with increased contact (friction) with the roads. This means the gas particles inside the tyre gain more kinetic energy and collide with the inside of the tyre more frequently and harder. The pressure inside the tyres will increase and could cause the tyre to burst or explode.

States of Matter The Particle Model
Teaching Ideas

Learning Objective:	To understand how particles are arranged in the three states of matter.
Success Criteria:	• To identify the arrangement of particles in each state of matter. • To define density. • To link the arrangement of particles in each state of matter to their properties.
Context:	This is the second lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Starter

As students enter the classroom and settle, on slide 1 is a picture of a beach and a question asking 'Can you identify any states of matter in this picture?' This allows students to recall the three states of matter from the previous lesson and apply them to the new scenario.

Main Activities

Matter Key Points

Slides 3-4: Recap matter key points from previous lesson on slide 3 and introduce students to the concept of particles within matter on slide 4.

Arranging Particles: Thinking Activity

Slides 5-7: Students follow the instructions on slides 5 and 6 and work in pairs to place their stationery into how they think the particles are arranged in solids, liquids or gases. Answers are shown on slide 7.

The History of the Particle Mod**el**

Slides 8-10: Show the condensed history of the particle model on slides 8 – 11. Also, emphasise what a model is using slide 8 and that models are used to explain scientific phenomena that are difficult to see.

Density Key Points

Slides 11-12: Define density on slide 11 and use the suitcase picture to gauge students understanding of this concept. The suitcase shows a high density, as there are a lot of clothes (representing mass) in a fixed volume (the suitcase). Ask students if you took clothes out of the suitcase, would it now become more or less dense? Answer = less dense. Ask the students if you unloaded the same amount of clothes into a bigger suitcase would it now become more or less dense? Answer = less dense. Show students the arrangement of particles in solids, liquids and gases and now refer to how dense they are using slide 12.

Analogy Activity

Slides 13-14: Students write a sentence in their book to compare each picture to a state of matter. Extension tasks are given, to allow students to create their own comparisons to everyday scenarios (for example being on the London Underground during rush hour could be identified as a solid) and secondly to include the word 'density' in their analogy. Example answers are given on slide 14.

Particle Model Key Points

Slides 15 - 18: Describe how the arrangement of particles in each state of matter give them defined properties using slides 15 -18.

Gas Pressure Key Points

Slides 19-20: Describe how the arrangement of particles in gas mean it is often compressed and this causes gas pressure using slide 19. A factor that can increase gas pressure is temperature, as it described on slide 20 and ask students 'Why can this be dangerous?' and 'Have you seen any warning symbols anywhere?' For example on deodorant and hairspray canisters and also vehicles transporting compressed gases. These are often labelled 'flammable'.

The Particle Model Differentiated Activity Worksheet

Students complete the higher ability worksheet to define density, draw the arrangement of particles in solids, liquids and gases, link the properties of solids, liquids and gases to the arrangement of their particles and describe the effects of gas pressure. Or students complete the lower ability worksheet to identify the arrangement of particles in solids, liquids and gases, identify the properties of solids, liquids and gases, compare densities in solids, liquids and gases and show how temperature affect gas pressure as a diagram. At the end of each worksheet are tick boxes that can be completed by either the student, peer or teacher matching to each point of the success criteria.

The Particle Model Mini Assessment Worksheet

Students follow the worksheet to demonstrate their knowledge of the particle model by answering exam style questions.

There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Students use the '3, 2, 1 Lift Off' mini plenary on slide 21 of the PowerPoint. Students write in their books three keywords, two facts they have learned today and one question about the topic they have. Remind the students of today's success criteria on slide 18 of the PowerPoint. Remind the students of today's success criteria on slide 22 of the PowerPoint.

Suggested Home learning:

Students should complete **Particle Model Homework Activity Sheet**.

Changing State **Quick Assessment**

1. Identify the change of state happening:

a. Chocolate being left in a warm room:

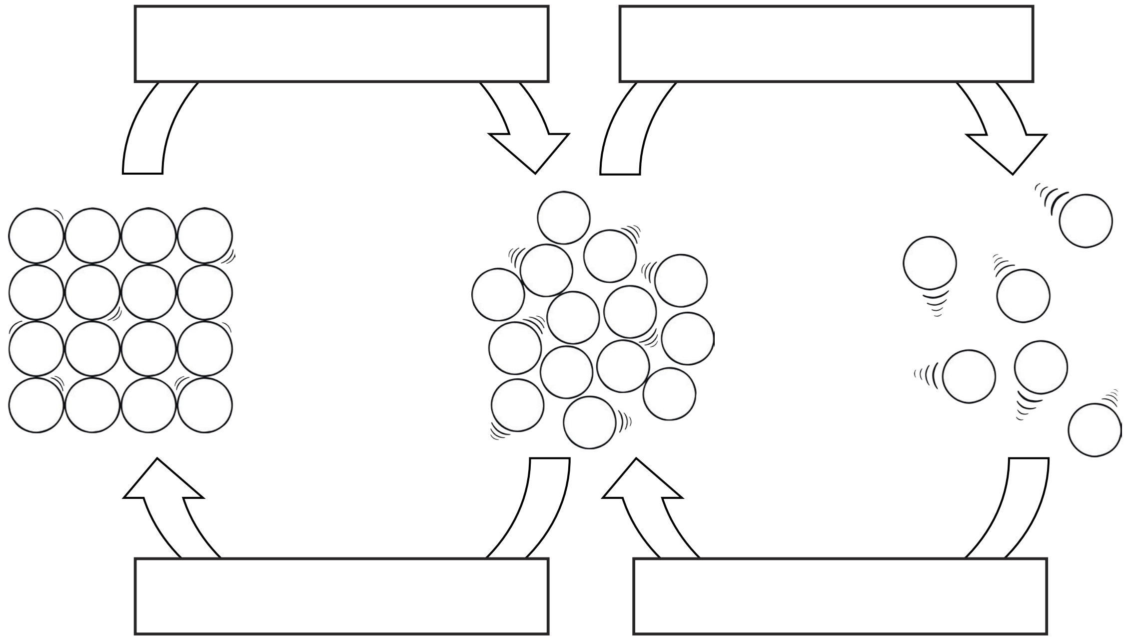
b. Water being placed in the freezer:

c. A puddle disappearing:

d. Water droplets on the outside of a cold drinks can:

e. A hairdryer being used on wet hair:

2. In each box, write the change of state that is taking place:



Challenge: Can you add your own extra arrows to show the changes of state called:

- Sublimation?
- Deposition?

3. Rahul takes a shower, makes a cup of tea and then hangs his washing outside to dry. For each scenario **identify** the change(s) of state happening and **describe** what is happening to the water molecules:

a. Turning the shower on and the mirror 'misting' over:

Change(s) of state:

Description of what is happening to the water molecules:

b. Turning the kettle on and steam appearing out of the spout:

Change(s) of state:

Description of what is happening to the water molecules:

c. Hanging wet washing outside to dry on a sunny day:

Change(s) of state:

Description of what is happening to the water molecules:

Learning Objectives:

- ☐ I can identify everyday changes of state.
- ☐ I can identify which change of state is happening.
- ☐ I can describe what happens as matter changes between states.

Changing State Quick Assessment **Answers**

1. Identify the change of state happening:

a. Chocolate being left in a warm room: **melting**

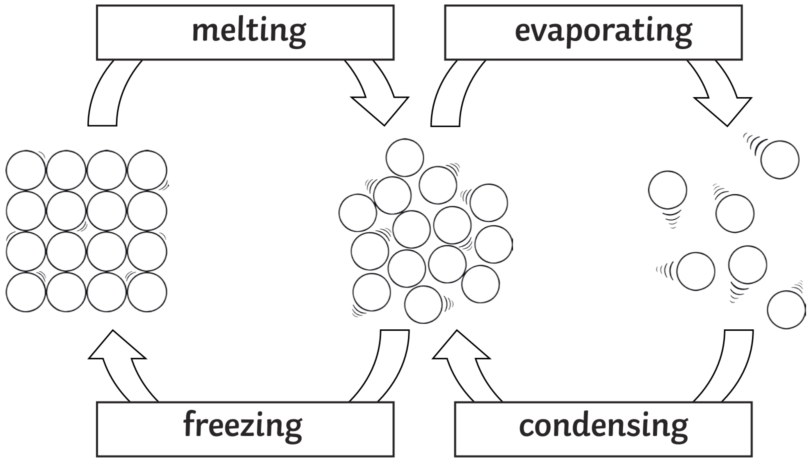
b. Water being placed in the freezer: **freezing**

c. A puddle disappearing: **evaporating/evaporation**

d. Water droplets on the outside of a cold drinks can: **condensing/condensation**

e. A hairdryer being used on wet hair: **evaporating/evaporation. This evaporation process would happen naturally, but hairdryers accelerate it. However, when there is high humidity and water already in the air, this happens at a low rate, if at all.**

2. In each box, write the change of state that is taking place:



Challenge:

For sublimation an arrow should be drawn from solid to gas, bypassing liquids.

For deposition an arrow should be drawn from gas to solid, bypassing liquids.

3. a. Turning the shower on and the mirror 'misting' over:

Change(s) of state: **Evaporation from the hot water and then condensation**

Description of what is happening to the water molecules: **The water molecules gain kinetic energy and move apart, some gain enough energy to change from a liquid to gas state. When they collide with a cold mirror, they lose this energy and collect as liquid water droplets.**

b. Turning the kettle on and steam appearing out of the spout:

Change(s) of state: **Evaporation**

Description of what is happening to the water molecules: **The water molecules gain kinetic energy and move apart, some gain enough to change from a liquid to a gas state.**

c. Hanging wet washing outside to dry on a sunny day:

Change(s) of state: **Evaporation**

Description of what is happening to the water molecules: **The water molecules on the clothes gain kinetic energy and move apart, most gain enough to change from a liquid to a gas state and thus move off the clothes. Similar to the hairdryer scenario, if there is high humidity and water already in the air, this happens at a low rate, if at all.**

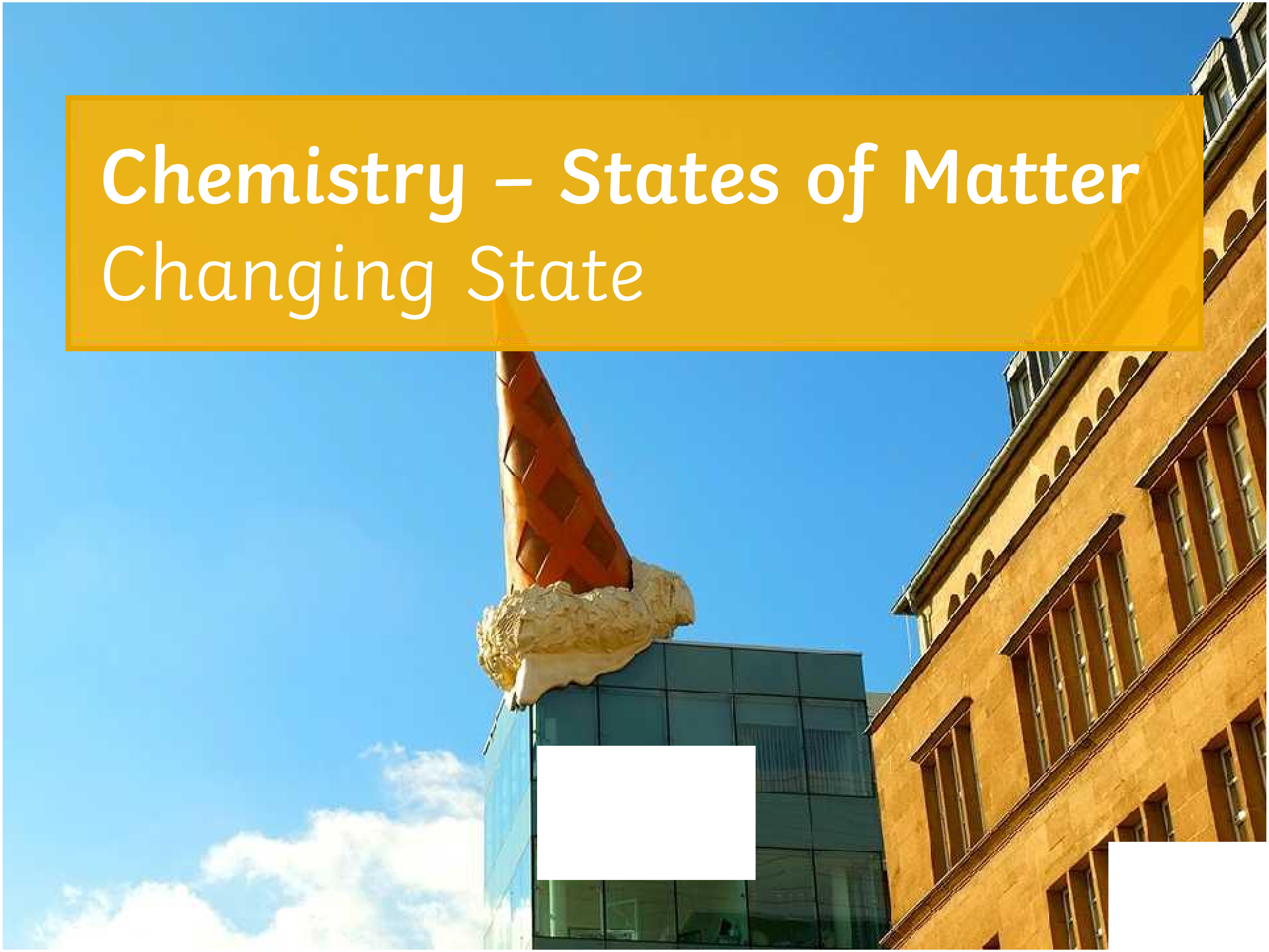
Changing State Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can identify some everyday changes of state.	You can identify most everyday changes of state.	You can identify all everyday changes of state.
You can use some keywords to define simple changes of state.	You can use most keywords to define the most common changes of state.	You can use all keywords to define all changes of state including sublimation and deposition.
You can describe how particles are arranged differently in each state of matter.	You can describe how the arrangement of particles changes from one state to another.	You can describe and explain how the arrangement of particles changes from one state to another.

Next Steps:

Chemistry – States of Matter
Changing State



Learning Objective

- To understand how matter can change from one state to another.

Success Criteria

- To list the different changes of state.
- To identify which change of state is happening.
- To describe what happens as matter changes between states.

Starter

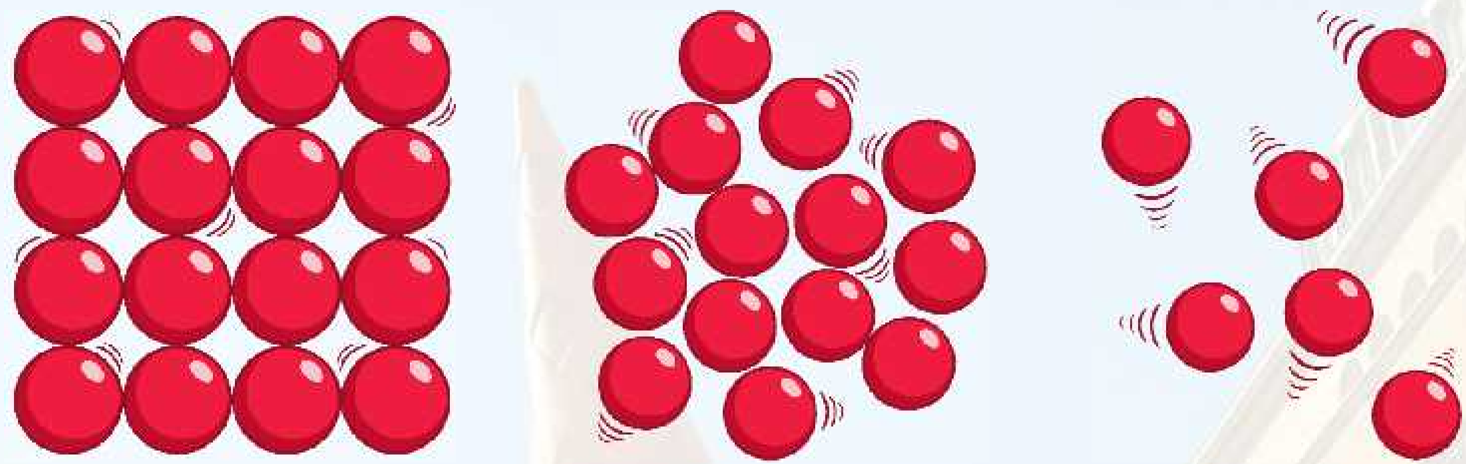
What connects these pictures?



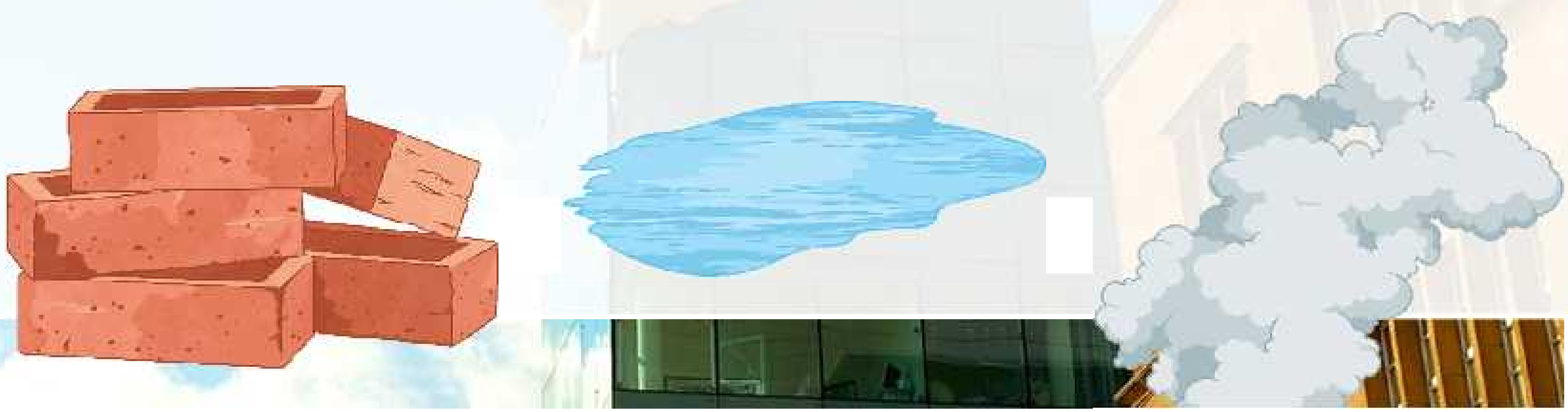
Challenge: What is the opposite of your word?

States of Matter Recap

There are **three** states of matter:



solids | liquids | gases



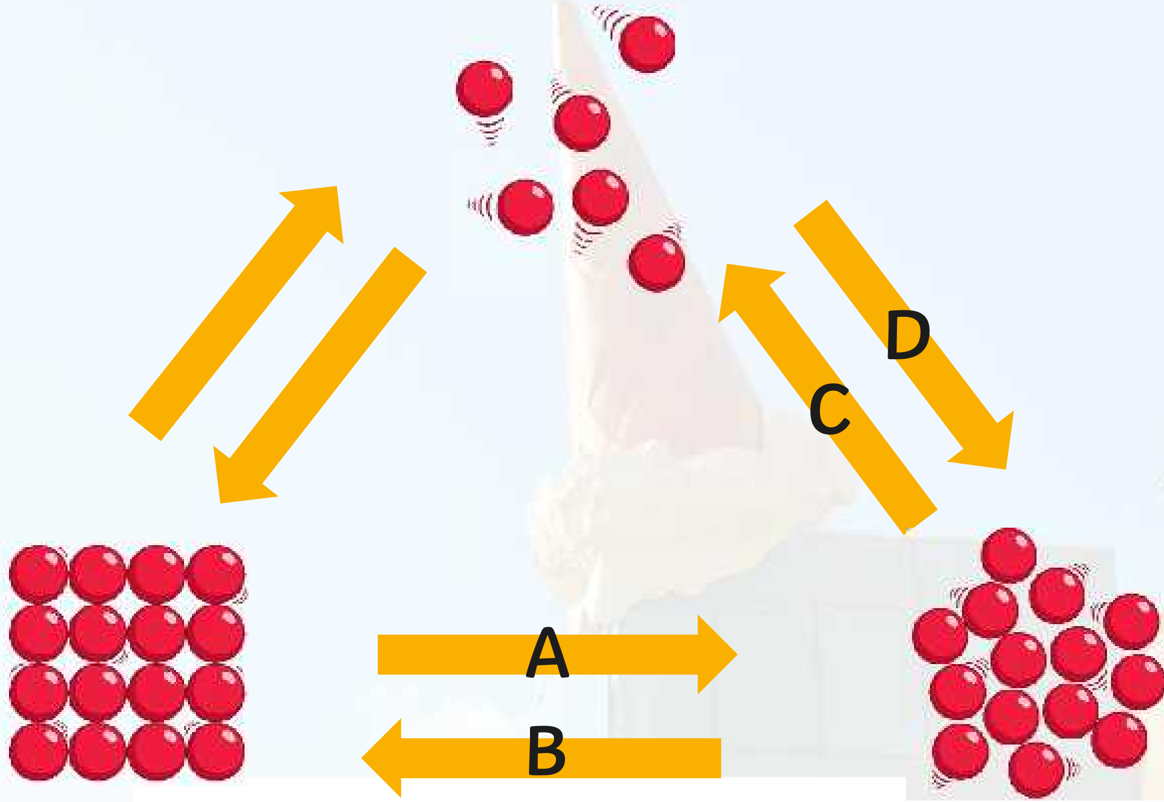
Changing State

Matter can change from one state to another.

This means the particles will be arranged differently and so the properties of the substance will change.

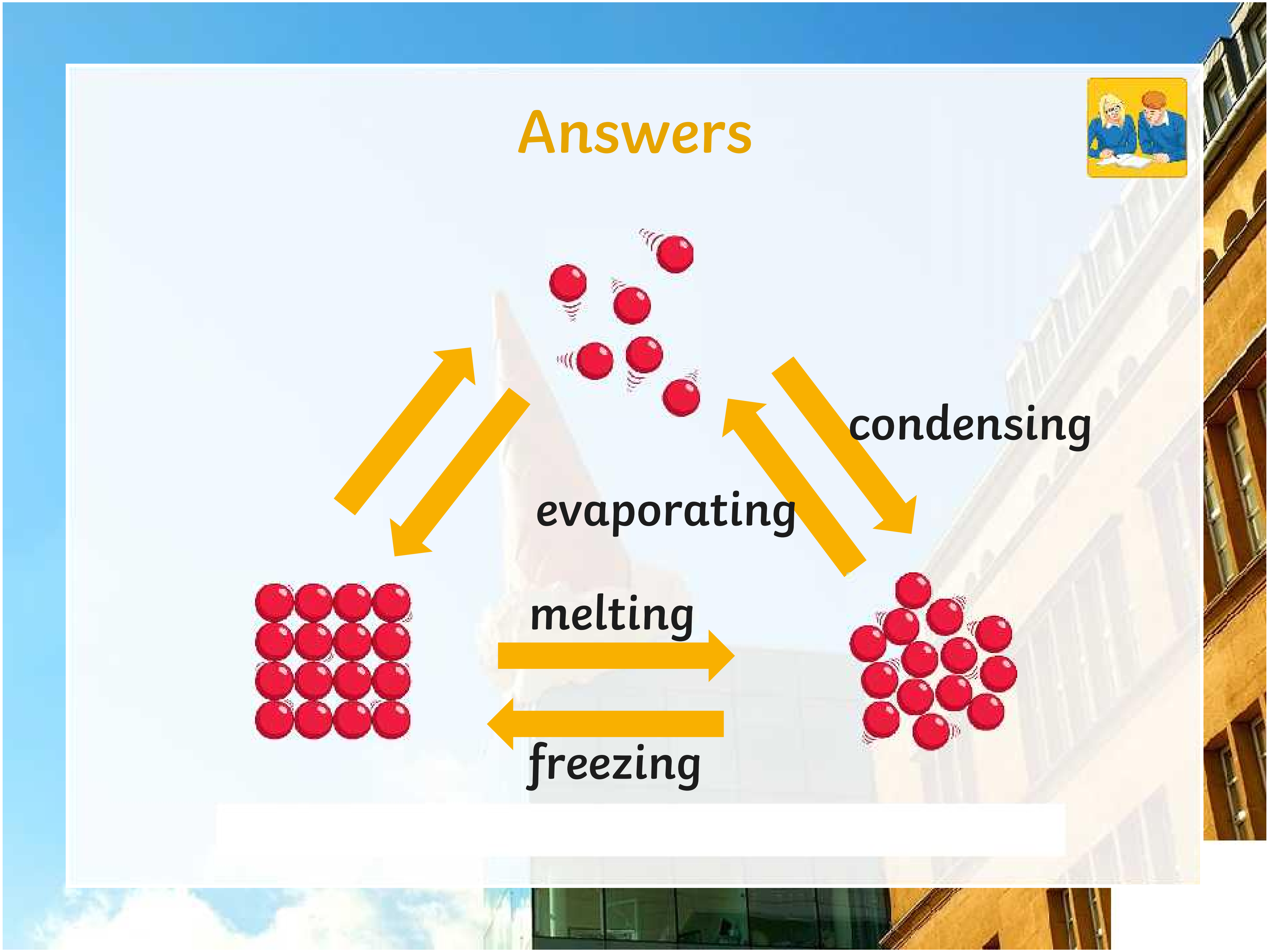
Identifying Changes Activity

In pairs you have two minutes to define the keywords for each change of state from letters A to D!

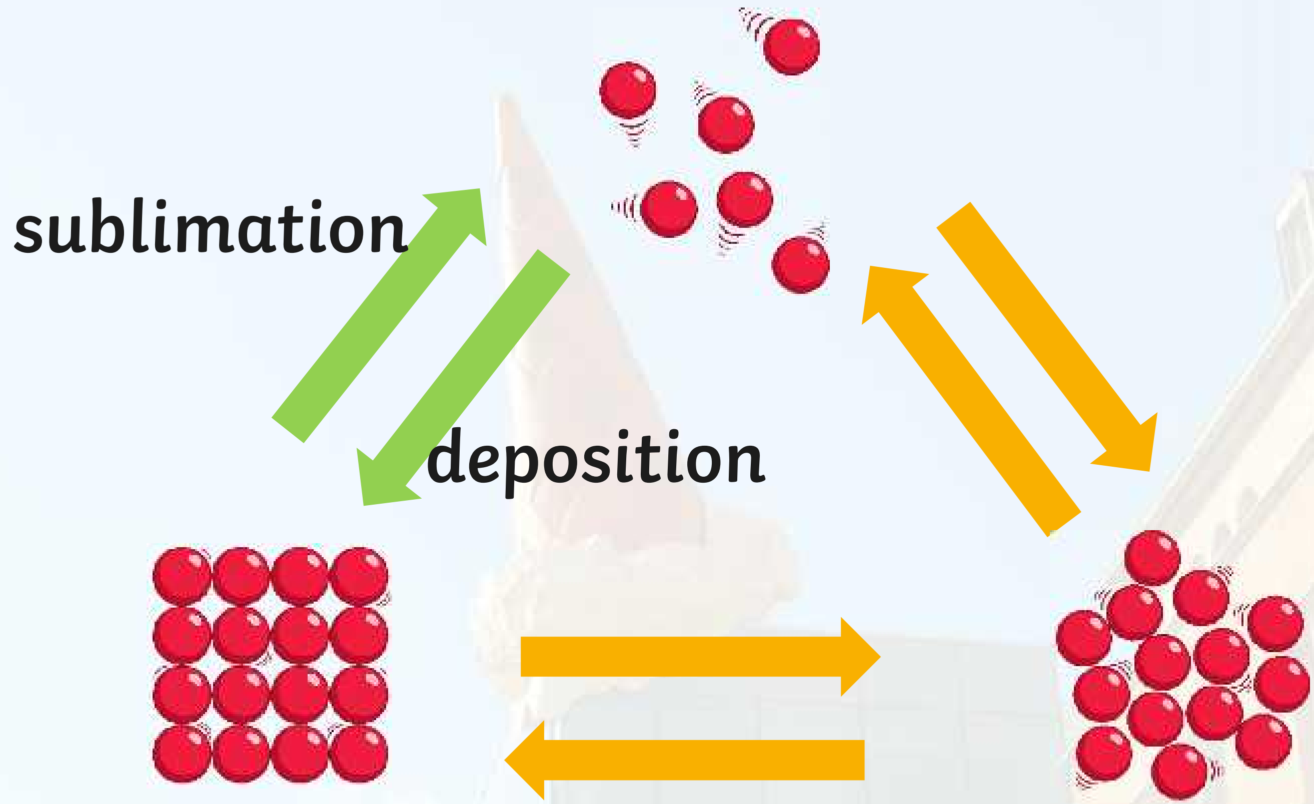


Timer

One minute remaining!


Answers
condensing
evaporating
melting
freezing

New Keywords



New Keywords


By Christopher from Salem, via Wikimedia Commons

sublimation

Dry ice happens because solid carbon dioxide sublimates at room temperature and turns straight into a gas!

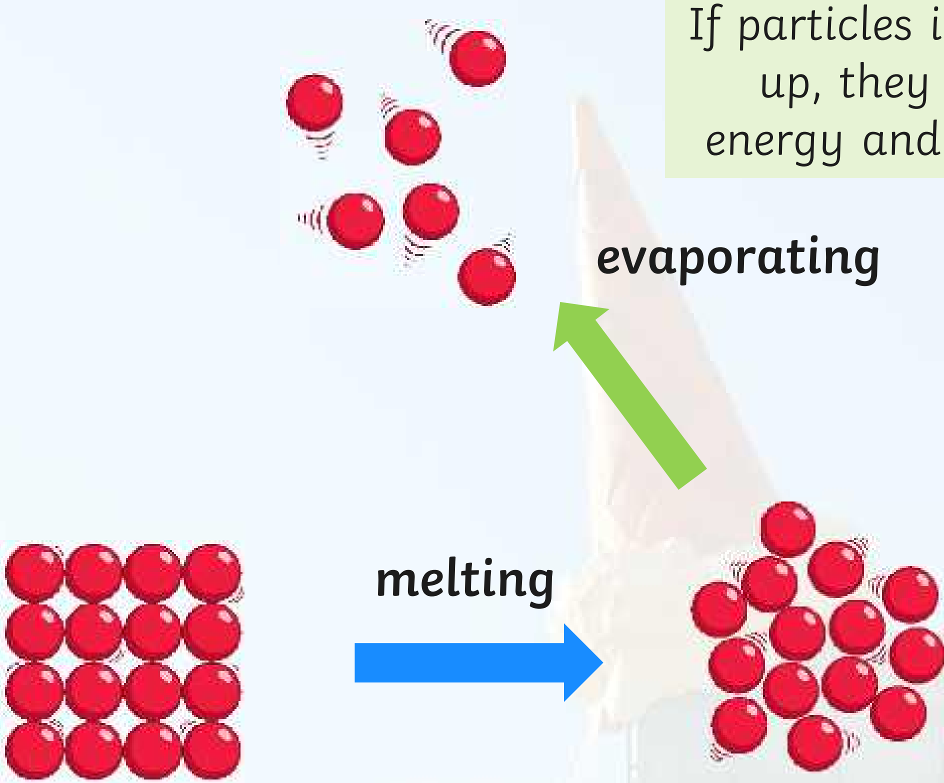
deposition

Snow happens because gaseous water vapour deposits in clouds and turns straight into a solid!


Photo courtesy of james_mann, via Flickr.com

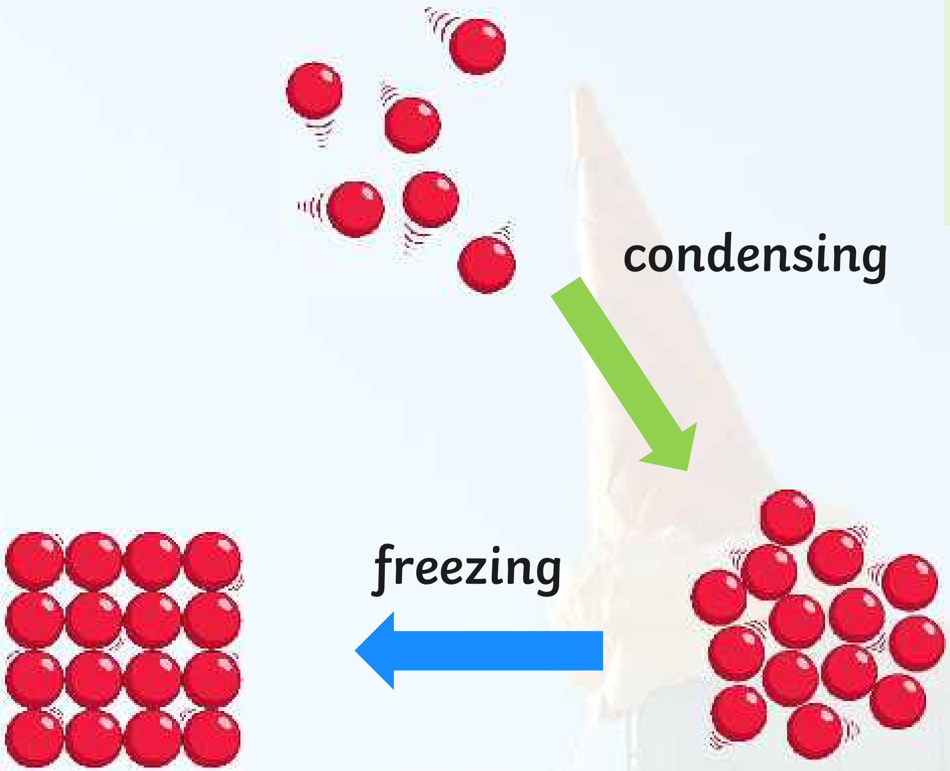
How Does This Happen?

If particles in a liquid are heated up, they gain more kinetic energy and move further apart.



If particles in a solid are heated up, they gain kinetic energy and move slightly apart.

How Does This Happen?



If particles in a gas are cooled, they have less kinetic energy and move closer together.

If particles in a liquid are cooled, they have less kinetic energy and move even closer together.

Melting and Boiling Points

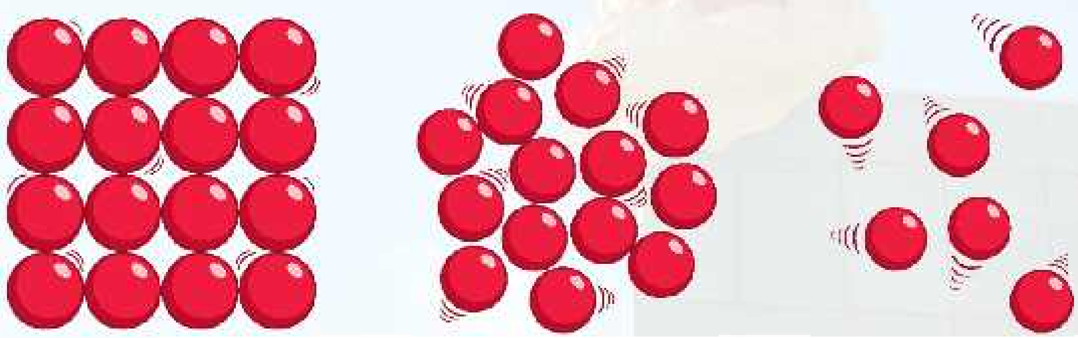
- The element with the highest melting point is tungsten.
- It has the symbol 'W' from the word 'wolfram' from the mineral it was discovered in.
- Tungsten comes from Swedish for 'heavy stone'.

Pause for Thought
Tungsten is often used as the filament inside of lightbulbs - why do you think this is?

Melting and Boiling Points

To overcome **some** of the forces between the particles and make tungsten **melt** from a solid into a liquid, you must heat it to 3422°C!

To overcome **all** of the forces between the particles and make tungsten **boil** from a liquid into a gas, you must heat it to 5555°C!



Melting and Boiling Points

The element with the **lowest** melting point is **helium**.

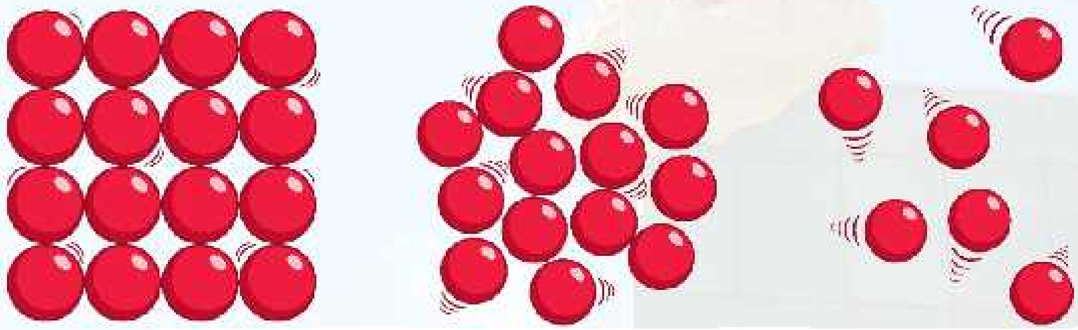
It has the symbol 'He' from the Greek God 'Helios' who was thought to drive his chariot of the sun across the sky every day.

Helium exists as a gas at room temperature and is often used in balloons as it is **less dense** than air.

Melting and Boiling Points

To turn helium from a gas into a liquid
you must cool it to below -268°C!

To turn helium into a solid you must cool
it even further to below -272°C!



Definitions

- **Melting:** a s___________ changing into a l___________.
- **Evaporating:** a _________ changing into a ___________.
- **Condensing:** a __________ changing into a ___________.
- **Freezing:** a ___________ changing into a ____________.

Words to use: solid, liquid and gas.

Key Terms
Check your spelling as you write each term down.

Definitions

- **Melting:** a s__________ changing into a l__________.
- **Evaporating:** a l________ changing into a g_________.
- **Condensing:** a g________ changing into a l_________.
- **Freezing:** a l__________ changing into a s___________.

Challenge: Can you remember the two new keywords?

Key Terms
Check your spelling as you write each term down.

Definitions

- **Melting:** a solid changing into a liquid.
- **Evaporating:** a liquid changing into a gas.
- **Condensing:** a gas changing into a liquid.
- **Freezing:** a liquid changing into a solid.

Challenge:

Sublimation: a solid changing directly into a gas.

Deposition: a gas changing directly into a solid.

Investigating Freezing Points Practical

Stearic acid is a white waxy solid at room temperature.

You will be given stearic acid as a **hot** liquid and will record when it becomes a solid (**solidifies**).

Lab Safety Rules

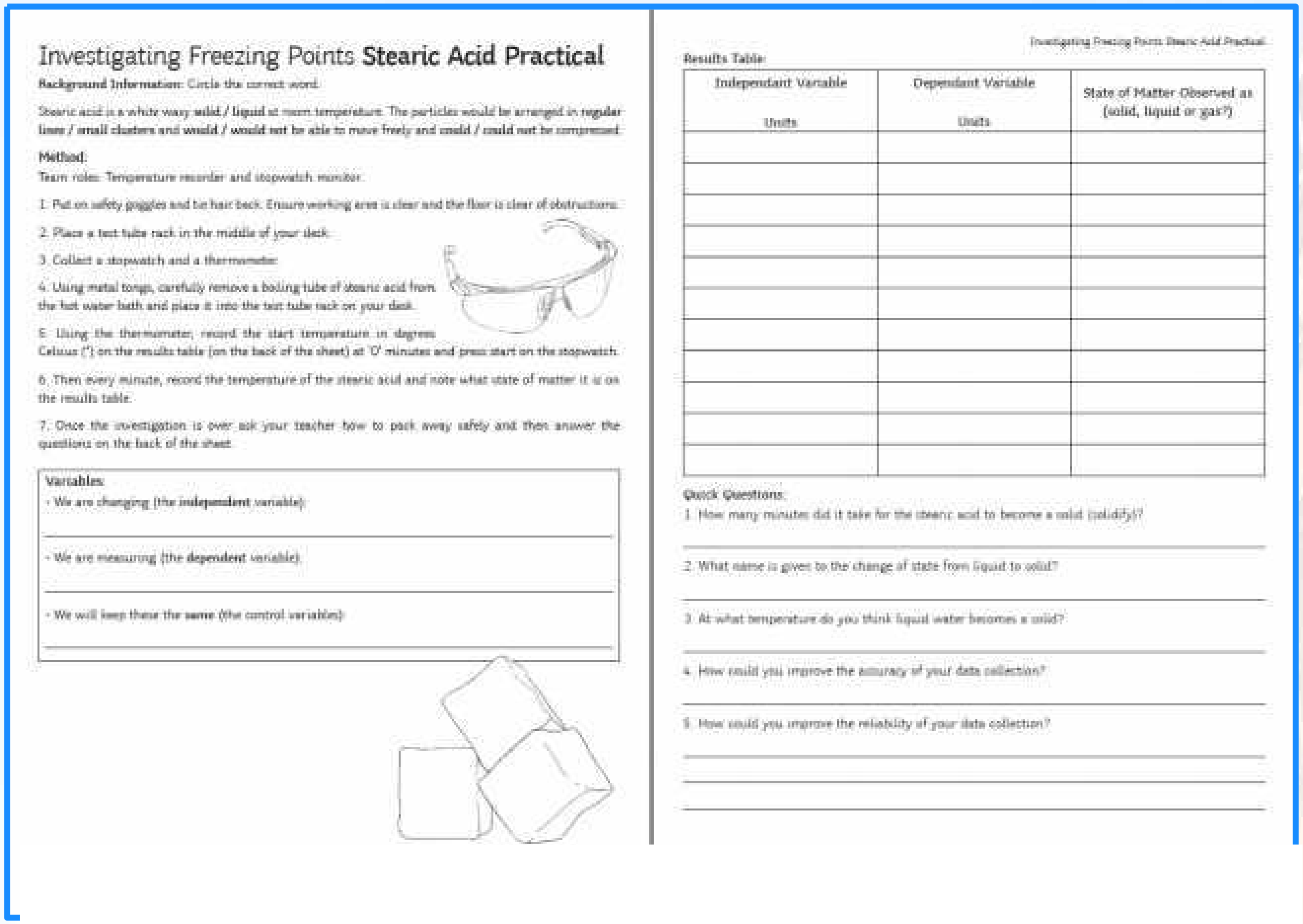
Aim: Follow the worksheet to safely complete the practical.

Remember:

- Stand up at all times.
- Wear safety goggles at all times.
- Tie long hair up.
- Report any accidents to the teacher or the TA asap.
- Do not take your eyes off your equipment.
- Work well as a team and ask how to pack away.
- Most of all stay focused and enjoy!

Plenary

Complete the five quick questions on your practical sheet.



Investigating Freezing Points **Stearic Acid Practical**

Background Information: Circle the correct word.

Stearic acid is a white waxy **solid / liquid** at room temperature. The particles would be arranged in **regular lines / small clusters** and **would / would not** be able to move freely and **could / could not** be compressed.

Method:

Team roles: Temperature recorder and stopwatch monitor.

1. Put on safety goggles and tie hair back. Ensure working area is clear and the floor is clear of obstructions.
2. Place a test tube rack in the middle of your desk.
3. Collect a stopwatch and a thermometer.
4. Using metal tongs, carefully remove a boiling tube of stearic acid from the hot water bath and place it into the test tube rack on your desk.
5. Using the thermometer, record the start temperature in degrees Celsius (°) on the results table (on the back of the sheet) at '0' minutes and press start on the stopwatch.
6. Then every minute, record the temperature of the stearic acid and note what state of matter it is on the results table.
7. Once the investigation is over ask your teacher how to pack away safely and then answer the questions on the back of the sheet.

Variables:

- We are changing (the **independent** variable):
- We are measuring (the **dependent** variable):
- We will keep these the **same** (the control variables):

Results Table:

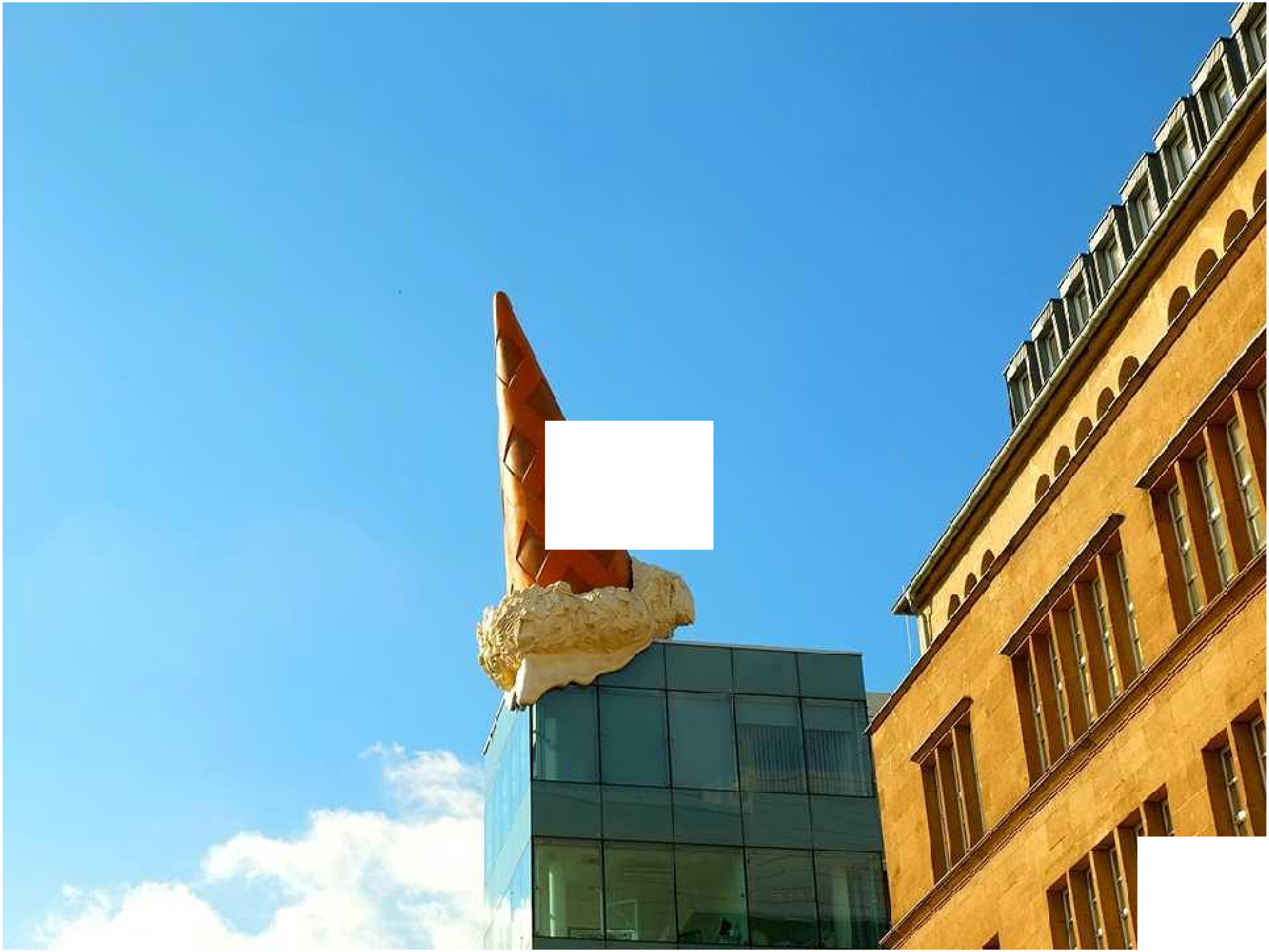
Independant Variable Units	Dependant Variable Units	State of Matter Observed as (solid, liquid or gas?)

Quick Questions:

1. How many minutes did it take for the stearic acid to become a solid (solidify)?
2. What name is given to the change of state from liquid to solid?
3. At what temperature do you think liquid water becomes a solid?
4. How could you improve the accuracy of your data collection?
5. How could you improve the reliability of your data collection?

What Did You Achieve Today?

- I can list the different changes of state.
- I can identify which change of state is happening.
- I can describe what happens as matter changes between states.



States of Matter Changing States
Teaching Ideas

Learning Objective: To understand how matter can change from one state to another.

Success Criteria:

- To list the different changes of state.
- To identify which change of state is happening.
- To describe what happens as matter changes between states.

Context: This is the third lesson of the topic of ‘States of Matter’ in key stage 3 Chemistry.

Starter

As students enter the classroom and settle, on slide 3 are three pictures, one of an ice cream melting, one of frost melting on a twig and finally one of cheese melted on nachos. There is a question asking, ‘What connects these pictures?’ This allows students to identify one of the keywords for today’s lesson (melting) and allows the teacher to clarify any misconceptions.

Main Activities

States of Matter Recap

Slides 4-5: Recap the three states of matter key points from previous lesson on slide 4 and introduce students to the concept of particles changing states on slide 5.

Identifying Changes Activity

Slides 6-11: Students follow the instructions on slide 6 and work in pairs to identify keywords they may already know to match to the picture showing. Answers are shown on slide 7. Two new keywords ‘sublimation’ and ‘deposition’ are introduced and an example of each are given on slide 9. An explanation of, ‘How does this happen?’ For freezing, melting condensing and evaporating happen are given slides 10 and 11.

Melting and Boiling Points

Slides 12-15: Show students the information about melting and boiling points, using tungsten (the element with the highest melting point) and helium (the element with the lowest melting point) as case studies. Pictorial explanations are given on slides 13 and 15 as to how each element changes state.

Definitions

Slides 16-18: Students are given a gap fill to complete on slide 16 and more prompts are given on slide 17 to note down the keywords covered so far in today’s lesson. An extension question is also given on slide 17 to remember the two new keywords sublimation and deposition and the definitions of each. The answers are shown on slide 18.

Investigating Freezing Points Practical Worksheet

Slides 19-20: Give students a brief introduction to the stearic acid practical. Stearic acid should be set up at the beginning of the lesson in boiling tubes, with a thermometer inside each and placed in a water bath (approx. 70°c). Students then follow the worksheet to understand the background, variables. A pre drawn results table is given, although this could be drawn independently by more able students. Students record the temperature of the stearic acid every minute and also note what state of matter it currently is. General science laboratory rules are given on slide 20. There is also a teacher feedback sheet on practical skills which provides an opportunity to record and feedback on how students performed during this practical.

Plenary

Students complete the five quick questions on the Investigating **Freezing Points Practical Worksheet**. Remind the students of today's success criteria on slide 22 of the PowerPoint.

Suggested Home Learning:

Students could complete **Particle Model Quick Assessment Sheet** or could plot their data as a graph using the prompts on the worksheet **Investigating Freezing Points Practical Worksheet**.

Investigating Freezing Points **Stearic Acid Practical**

Background Information: Circle the correct word.

Stearic acid is a white waxy **solid / liquid** at room temperature. The particles would be arranged in **regular lines / small clusters** and **would / would not** be able to move freely and **could / could not** be compressed.

Method:

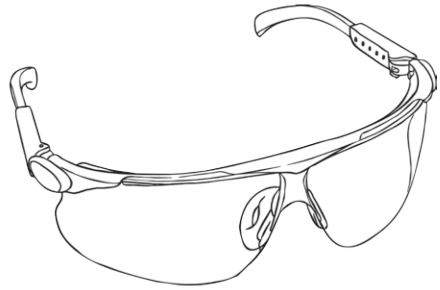
Team roles: Temperature recorder and stopwatch monitor.

1. Put on safety goggles and tie hair back. Ensure working area is clear and the floor is clear of obstructions.

2. Place a test tube rack in the middle of your desk.

3. Collect a stopwatch and a thermometer.

4. Using metal tongs, carefully remove a boiling tube of stearic acid from the hot water bath and place it into the test tube rack on your desk.



5. Using the thermometer, record the start temperature in degrees Celsius (°C) on the results table (on the back of the sheet) at '0' minutes and press start on the stopwatch.

6. Then every minute, record the temperature of the stearic acid and note what state of matter it is on the results table.

7. Once the investigation is over ask your teacher how to pack away safely and then answer the questions on the back of the sheet.

Variables:

- We are changing (the **independent** variable):

- We are measuring (the **dependent** variable):

- We will keep these the **same** (the control variables):

Results Table:

Independent Variable= Units=	Dependent Variable= Units=	State of Matter Observed as (solid, liquid or gas?)

Quick Questions:

1. How many minutes did it take for the stearic acid to become a solid (solidify)?

2. What name is given to the change of state from liquid to solid?

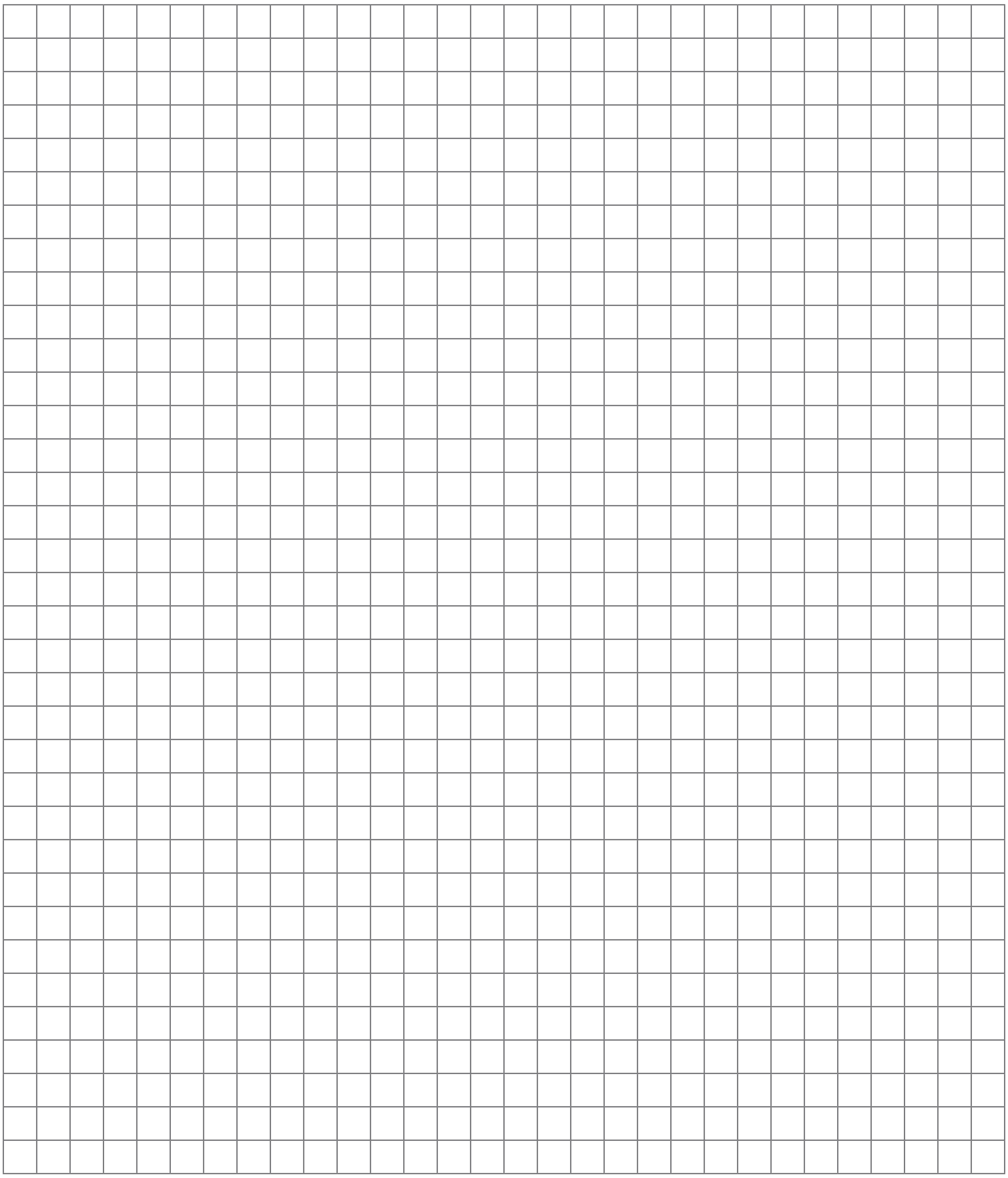
3. At what temperature do you think liquid water becomes a solid?

4. How could you improve the accuracy of your data collection?

5. How could you improve the reliability of your data collection?

Graph:

Temperature (°C) (Dependent variable)



Time (minutes) (Independent variable)

Graph:

Helpful tips:

The independent variable is always on the x-axis.

The dependent variable is always on the y-axis.

Stearic Acid Practical **Answers**

Variables:

The **independent** variable is time (minutes).

In this investigation, it is difficult for students to identify an independent variable, as you are not 'changing' time but observing it. However, as you are specifying the time intervals (every minute) it becomes the independent variable.

The **dependent** variable is temperature (°C).

The **control** variables: The start temperature of the stearic acid (°C) and the volume / amount of stearic acid used (cm^3).

Quick Questions:

1. Times may vary from student to student.

2. Freezing is the term given for when a liquid changes into a solid.

3. At 0°C fresh water will freeze, but saltwater is actually lower at -1.9°C!

4. To improve the accuracy of your data collection you could use a digital thermometer or a data logger.

5. To improve the reliability of your data collection you could repeat the experiment, two or three times, exclude any anomalies before calculating a mean.

Stearic Acid Practical Skills **Teacher Feedback**

Effort: 1 2 3 4 5

With teacher guidance, you can write down variables in this practical.	You can identify **some** variables in this practical.	You can identify **all** of the variables in this practical.
With teacher guidance, you can mostly follow a written method.	With teacher or peer guidance, you can follow a written method safely.	You can independently follow a written method safely.
With teacher guidance, you can collect results.	With teacher or peer guidance, you can collect accurate results.	You can independently collect accurate and valid results.
You can apply the keyword 'freezing' to this practical.	You can apply today's practical to an everyday situation of water freezing.	You can suggest ways of improving data collection in this practical.

Next Steps:

Diffusion Investigation

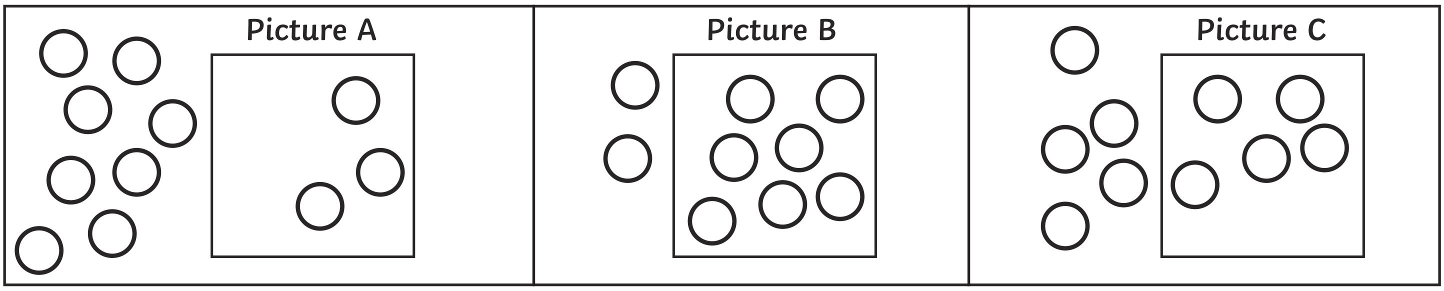
1. There are various different coloured balloons around the room. Your task is to identify the smell of each one!

Balloon Colour	Smell	Right or Wrong?

2. Explain how the smell of each balloon is getting to your nose. **Words to use**: particles, concentration, energy.

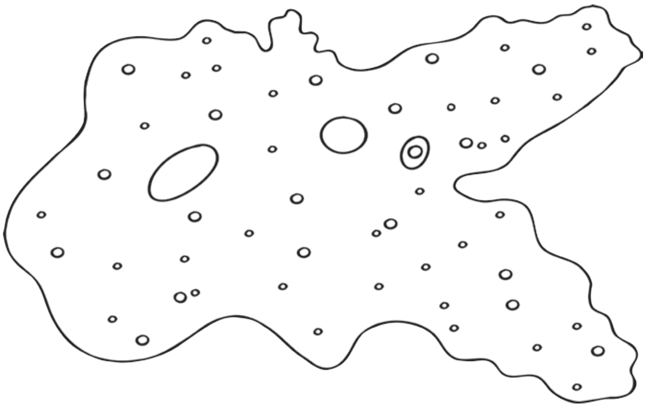
3. What might stop the smell getting to your nose? Or make it travel faster to your nose?

4. Look at the pictures below and draw a large clear arrow to show which way the particles would move (into or out of the box), based on the definition of diffusion.



Challenge: Can you think of any words to describe picture C?

5. Amoebas are single celled organisms (unicellular) that rely on diffusion to stay alive.



a. What structure surrounds the amoeba? Clue: think about what is outside of **animal** cells.

____

b. Amoebas perform respiration to release energy.

____

i. What gas would diffuse **into** the amoeba for use in respiration?

____

ii. What gas would diffuse **out of** the amoeba as a waste product of respiration?

____

Learning Objectives:

- ☐ I can explain how diffusion works in terms of particles.
- ☐ I can suggest factors that could affect the rate of diffusion.
- ☐ I can predict the movement of particles.
- ☐ I can link diffusion to the topic of cells.

Diffusion Investigation **Answers**

1. Answers will vary.

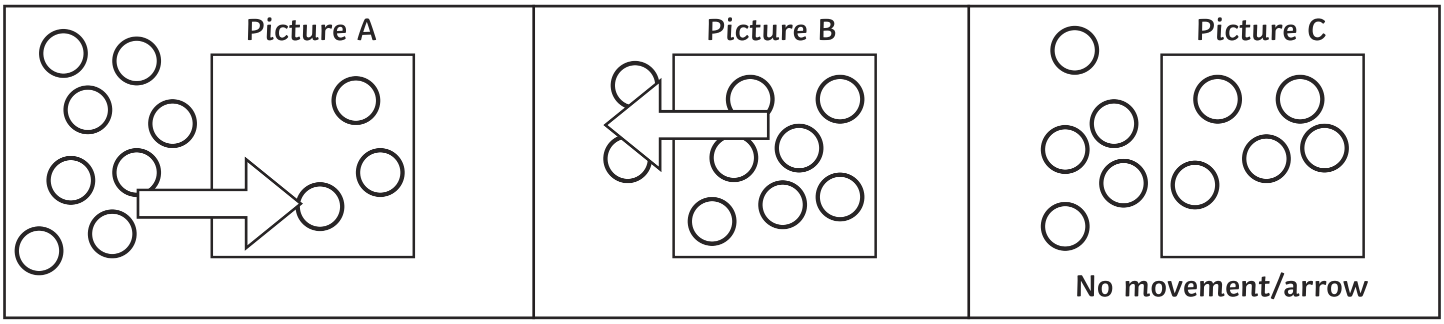
2. Students should refer to:

- the smell/chemical **particles**;
- **moving**;
- from a **high concentration** (inside the balloon);
- to a **low concentration** (outside the balloon);
- down a **concentration** gradient;
- with **no energy/passive** process.

3. Possible answers could include:

- how much of each smell was placed inside (link to concentration gradient);
- how thick the balloon material is (link to the size of the particles);
- the temperature of the room/smell;
- the state of matter of the smell (gases will diffuse faster than liquids);
- look at the pictures below and draw a large clear arrow to show which way the particles would move (into or out of the box), based on the definition of diffusion.

4.



Challenge: Answers to describe picture C could include 'equal', 'even' and 'balanced'. Use this as an opportunity to introduce the term 'equilibrium'.

5.

a. A cell membrane surrounds the amoeba.

b. *i*. Oxygen would diffuse **into** the amoeba for use in respiration.

b. *ii*. Carbon dioxide would diffuse **out of** the amoeba as a waste product in respiration.

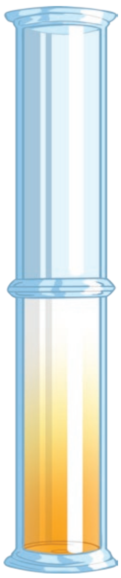
Diffusion Quick Assessment

1. Define diffusion:

2. Diffusion can happen in: (circle the correct answers)

   solids **liquids** **gases**

3. Explain your answer to question 2 using the particle model.



4. A teacher set up the following apparatus:

a. Describe what would happen to the bromine gas particles as the card in between the two glass jars was removed:

b. Why might the diffusion of this gas actually be slower than expected?

c. How could the teacher speed up the rate of diffusion in this experiment?

Learning Objectives:

- ☐ I can define diffusion.
- ☐ I can explain how diffusion works in terms of particles.
- ☐ I can suggest factors that could affect the rate of diffusion.
- ☐ I can predict the movement of particles.

Diffusion Quick Assessment **Answers**

1. Diffusion is:

• the movement of liquid or gas particles;

• from an area of high concentration;

• to an area of low concentration;

• down a concentration gradient;

• requiring no energy/it is a passive process.

2. Diffusion can happen in liquids and gases.

3. Diffusion can happen in liquids and gases because the particles are free to move, whereas in a solid the particles are fixed and can only vibrate on the spot.

4.

a. The bromine gas particles would diffuse from a high to low concentration and so move upwards.

b. The diffusion of this gas could be slower than expected due to any air particles colliding with the bromine gas particles and sending them off in another direction. This random movement of gases is known as Brownian motion.

c. The teacher could speed up the rate of diffusion in this experiment by increasing the amount of bromine gas used to create a steeper concentration gradient or increasing the temperature. (Size of molecule and state of matter are not applicable in this experiment as bromine gas is being used.)

Diffusion Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can define diffusion using **some** keywords.	You can define diffusion using **most** keywords.	You can define diffusion using **all** keywords.
You can **identify** that diffusion can only happen in liquids and gases.	You can **explain** why diffusion can only happen in liquids and gases using the particle model.	You can explain why diffusion can only happen in liquids and gases and **compare** this to solids using the particle model.
You can **state** that gas particles move quickly.	You can **describe** the random movement of gases due to collisions.	You can **apply** Brownian motion to the diffusion of gas particles in a particular experiment.
You can list **one** factor that would increase the rate of diffusion.	You can list **all** factors that would increase the rate of diffusion.	You can **select** which factors would increase the rate of diffusion in a particular experiment.

Next Steps:

Diffusion
Teaching Ideas

Learning Objective:	To understand how particles can move from one area to another.
Success Criteria:	• To define diffusion. • To explain how diffusion works in terms of the particle model. • To predict the movement of particles based on factors.
Context:	This is the fourth lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Starter

As students enter the classroom and settle, on slide 3 is a picture of burnt toast, with a question 'You know someone has burnt toast even when you're not in the same room. How?' This allows students to draw upon their everyday knowledge and start to deconstruct the steps of diffusion and allows the teacher to clarify any misconceptions. On slide 4 is a basic explanation of how the smell travelled with another question 'Does the smell linger forever?' Again to stimulate student's minds about equilibrium.

Main Activities

Diffusion Definition

Slides 5-7: Introduce students to the definition of diffusion on slide 5, with higher ability terms in bold. Show students slide 6 and ask them to think which states of matter could therefore diffuse, based on the definition whilst they copy the definition down. Pictures of the three states of matter are given as thinking prompts. The answers and explanation are given on slide 7.

Diffusion Demonstration

Slide 8: Show students slide 8 to introduce the potassium permanganate in water demonstration. Teacher note - schools should prepare their own risk assessment for this practical. Add a small amount of potassium permanganate to a large beaker of water and observe what happens. If time and resources permit, add the same amount of potassium permanganate to hot water and ask students to compare what happens.

'Is Like…because…' Analogy Activity

Slides 9-10: Students write a sentence in their book to compare each picture to diffusion. Extension tasks are given to allow students to firstly include four keywords in their answers to pictures one and two and secondly to create their own comparisons of diffusion to everyday scenarios. Example answers are given on slide 10.

Diffusion Activity Sheet

Slides 11-12: Students should complete the **Diffusion Activity Sheet**. For the first task, different coloured balloons should be sourced with different smells placed inside of them prior to the lesson commencing, for example coffee, vinegar, milkshake powder etc. Students should be given one balloon in small groups to identify the smell and record their answer on the pre drawn results table, then a bell or timer could be used to swap the balloons with another group until all have been identified. There is a column for students to self-assess their answers before moving onto the written questions. Question 5 on the activity sheet links to cells and respiration and there is a prompt on slide 12 to help with this synoptic style question.

Factors Affecting Diffusion

Slides 13-14: Show students the four factors affecting diffusion on slide 13 and explain the mechanisms behind these using slide 14.

Brownian Motion

Slides 15-16: Show students slide 15 and introduce the history behind Brownian motion. Show slide 16 to explain that therefore diffusion is slightly slower than expected in gases, due to the random motion of gas particles and collisions sending them off in different directions.

Plenary

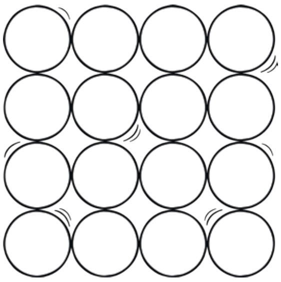
Slides 17-19: Show students slide 17 and ask them to work in pairs to identify the errors in a pretend student's conversation about diffusion. The errors are shown in red text on slide 18 and corrections are shown in green text on slide 19. Remind the students of today's success criteria on slide 20 of the PowerPoint.

Suggested Home Learning:

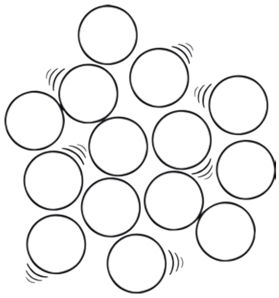
Students could complete **Diffusion Mini Assessment Sheet** or could complete **The Particulate Nature of Matter Homework Sheet** to review all four lessons on states of matter covered so far. Students absent for any lessons so far can catch up by using the **Key Revision Facts** worksheet and this can also be used as additional support to complete the home learning sheet.

States of Matter **Key Revision Facts**

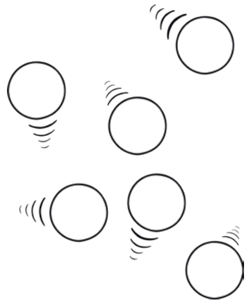
- The three factors that affect the properties of a substance are:
  1. the arrangement of the particles;
  2. what the particles are like;
  3. how the particles move.
- The three states of matter are solid, liquid and gas.
- The arrangement of particles in a solid, liquid and gas are shown below.



Solid



Liquid



Gas

- Properties of Solids, Liquids and Gases:

	volume	**shape**	**ease of flow**	**ease of compression**
solid	definite	definite	doesn't flow	not easily
liquid	definite	takes shape of container	flows easily	not easily
gas	no definite volume	takes shape of container	flows easily	easy

- When a substance reaches its melting point, it changes from a solid to a liquid.
- When a substance reaches its boiling point, it changes from a liquid to a gas.
- By knowing the melting and boiling points of a substance, it is possible to predict its state at room temperature 20 ^{o}C.
- Evaporation occurs when the particles escape from the liquid's surface.
- Condensation involves the change of state from a gas to a liquid.

- Sublimation is the change of state from a solid to a gas.
- Diffusion is the movement of particles from an area of high concentration to an area of low concentration.
- Examples of diffusion are; deodorant being sprayed and the smell spreading around the room, or oxygen diffuses from the lungs to the blood.
- The three factors that affect the rate of diffusion are:

1) concentration;
2) particle size;
3) temperature.

- Gas pressure is caused by particles hitting a surface.
- Factors affecting gas pressure are:

1) temperature (the higher the temperature the higher the pressure);
2) volume (the smaller the volume, the greater the pressure).

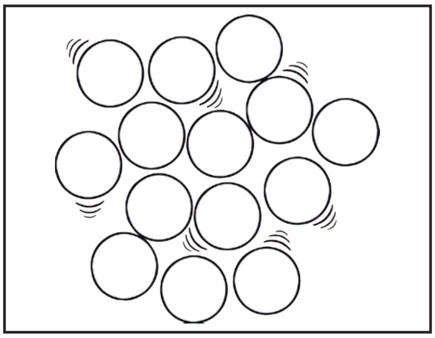
Name:	Class:	Date given:
		Date due in:

Particulate Nature **of Matter**

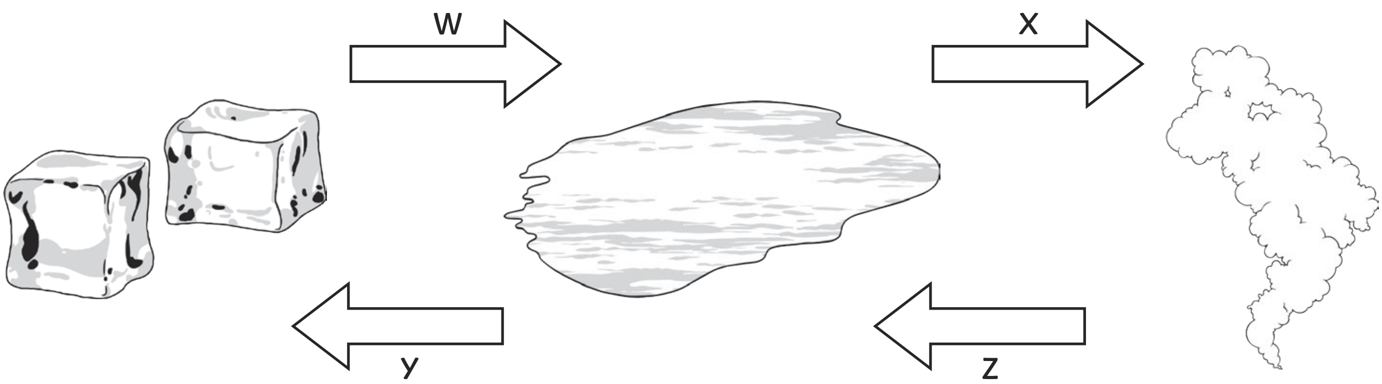
1. Complete the table by ticking or crossing the properties for each state of matter. [6]

Property	Solid	Liquid	Gas
High density			
Low density			
Fixed shape			
Fixed volume			
Easily squashed			
Flows			

2. Complete the particle diagrams for solid and gas states of matter. [2]



3. Look at the diagram.
   State the process which is occurring at each of the points labelled W, X, Y and Z. [4]



W: ______________________ X: ______________________

Y: ______________________ Z: ______________________

Susie blows up a balloon. First, she places the balloon in a bucket of ice water. She observes the balloon. She then removes the balloon and places it into a bucket of hot water. She observes the balloon again.

4a. Explain what Susie will observe when she puts the balloon in ice water. [3]

____

____

4b. Explain what Susie will observe when she puts the balloon in hot water. [3]

____

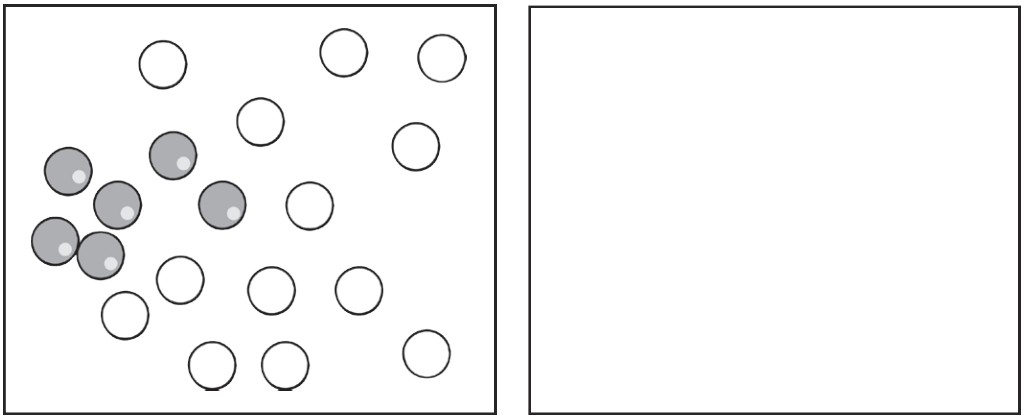
____

5. What is diffusion? [2]

____

____

6. Draw particles in the second box to show the smell after it has diffused into the air. [1]



Learning Outcomes (tick if achieved)

Q1	I can identify properties of SLG.	
Q2	I can draw particle arrangement of SLG.	
Q3	I can recall changes of state processes.	
Q4	I can describe how particles change with changing state.	
Q5	I can describe diffusion.	

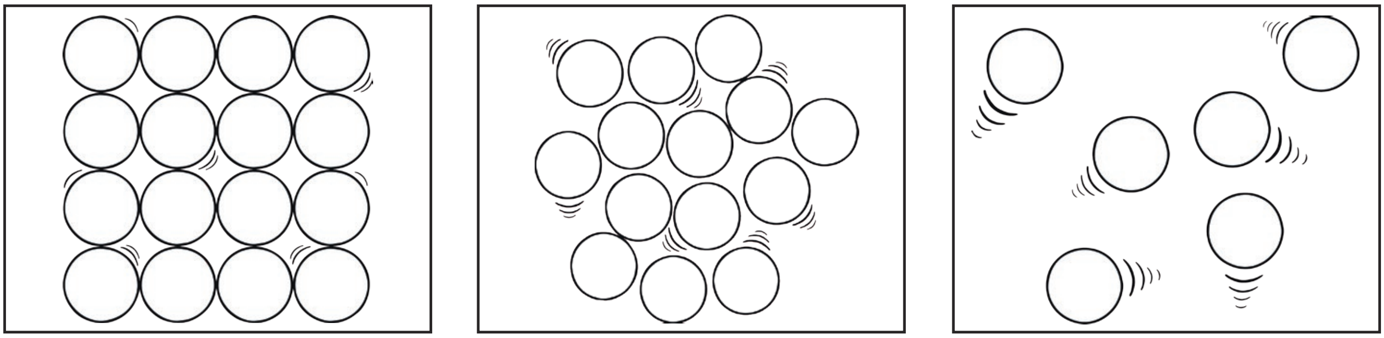
Particulate Nature of Matter **Answers**

1. Complete the table by ticking or crossing the properties for each state of matter. [6]

Property	Solid	Liquid	Gas
High density	✓	✗	✗
Low density	✗	✗	✓
Fixed shape	✓	✗	✗
Fixed volume	✓	✓	✗
Easily squashed	✗	✗	✓
Flows	✗	✓	✓

1 mark for each correct row

2. Complete the particle diagrams for solid and gas states of matter. [2]



3. Look at the diagram.
State the process which is occurring at each of the points labelled W, X, Y and Z. [4]

W: **melting**

X: **evaporating**

Y: **freezing**

Z: **condensing**

4a. Explain what Susie will observe when she puts the balloon in ice water. [3]

balloon will shrink / get smaller

because air particles condense

air particles have less energy

move less / collide with balloon wall less

decreased air pressure

4b. Explain what Susie will observe when she puts the balloon in hot water. [3]

balloon will expand / get bigger

because air particles spread out

air particles have more energy

move more / collide with balloon wall more

increased air pressure

5. What is diffusion? [2]

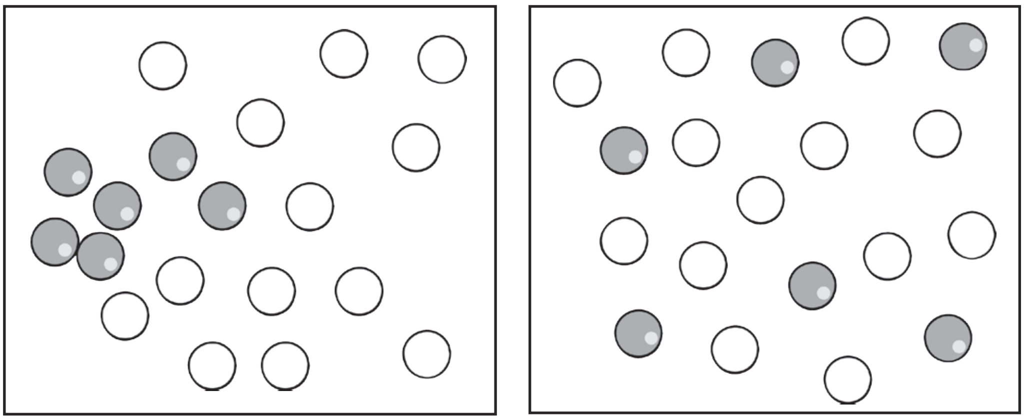
spreading out of particles

to reach equilibrium

2 marks for:

movement from area of high concentration to area of low concentration

6. Draw particles in the second box to show the smell after it has diffused into the air. [1]



Chemistry - States of Matter
Diffusion

Learning Objective

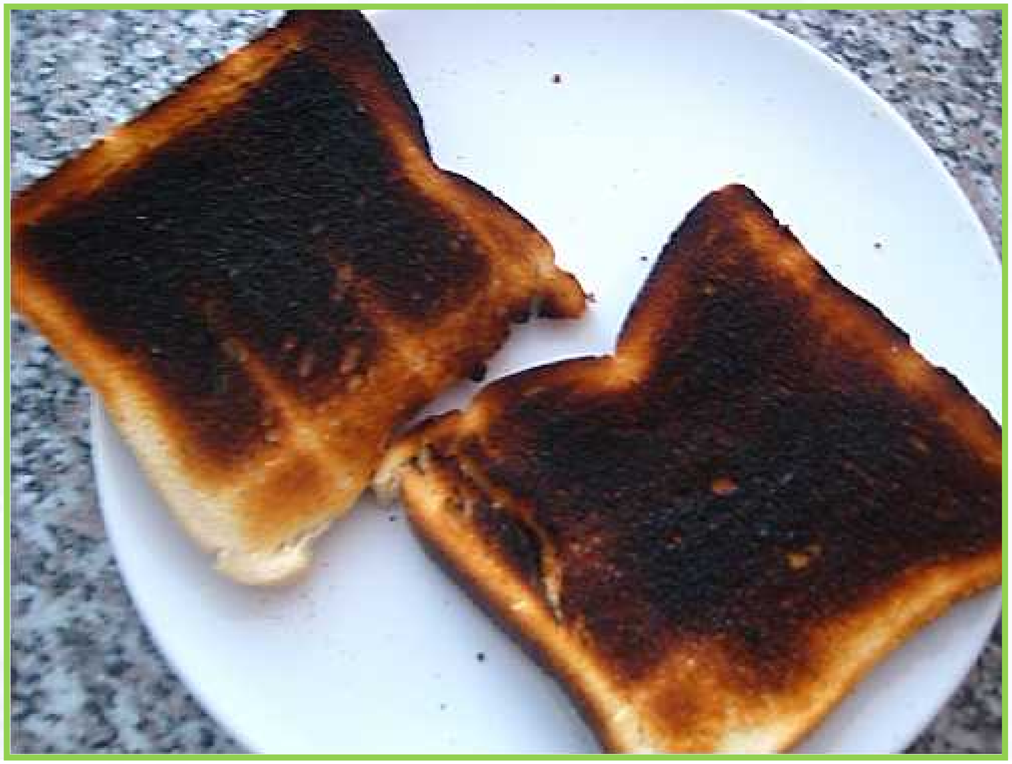
- To understand how particles can move from one area to another.

Success Criteria

- To define diffusion.
- To explain how diffusion works in terms of the particle model.
- To predict the movement of particles based on factors.

Starter

You know someone has burnt toast even when you're not in the same room. How?

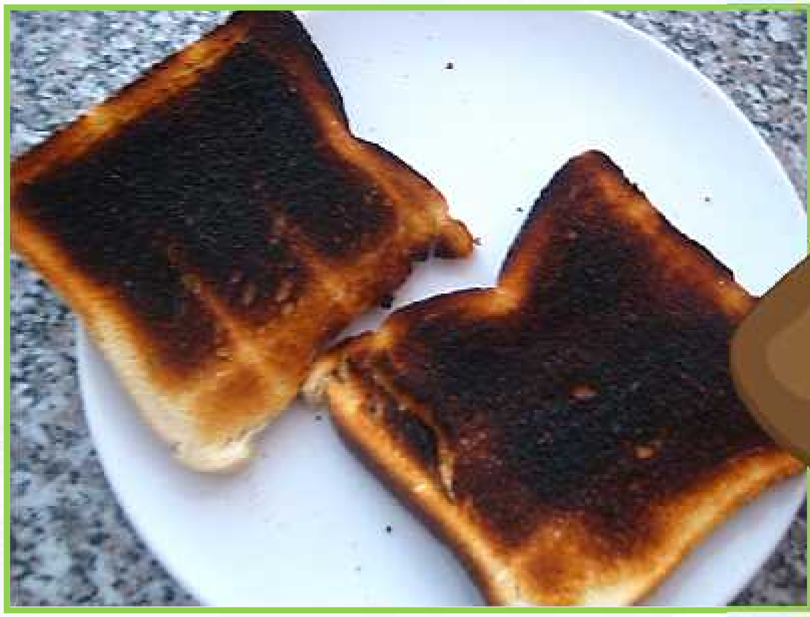


Burnt Toast!

The smell of the burnt toast **travelled** to our noses!

The chemical **particles** moved from an area of **high** concentration (the toaster) to an area of **lower** concentration (the next room).

Does the smell linger forever?



Diffusion Definition

The movement of particles from high concentration to low concentration, **down a concentration gradient**.

It requires no energy (**it is passive**).

Diffusion Definition

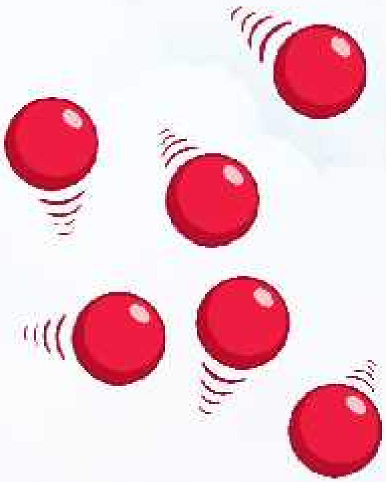
The movement of particles from high concentration to low concentration, **down a concentration gradient**.

It requires no energy (**it is passive**).

So which states of matter could diffuse?

solid

liquid



gas

Diffusion Definition

Solid particles cannot move. They are fixed. So they **could not** diffuse.

Liquid and gas particles can freely move, so they **could** diffuse.

Diffusion Demonstration

To get a solid to diffuse, you must **dissolve** it.

Watch as your teacher adds a small amount of potassium permanganate (a dark purple solid) to a beaker of water.

Diffusion is Like... Because...

Challenge 1: Can you include four keywords in your answer to pictures one and two?

Challenge 2: Can you think of your own analogy?

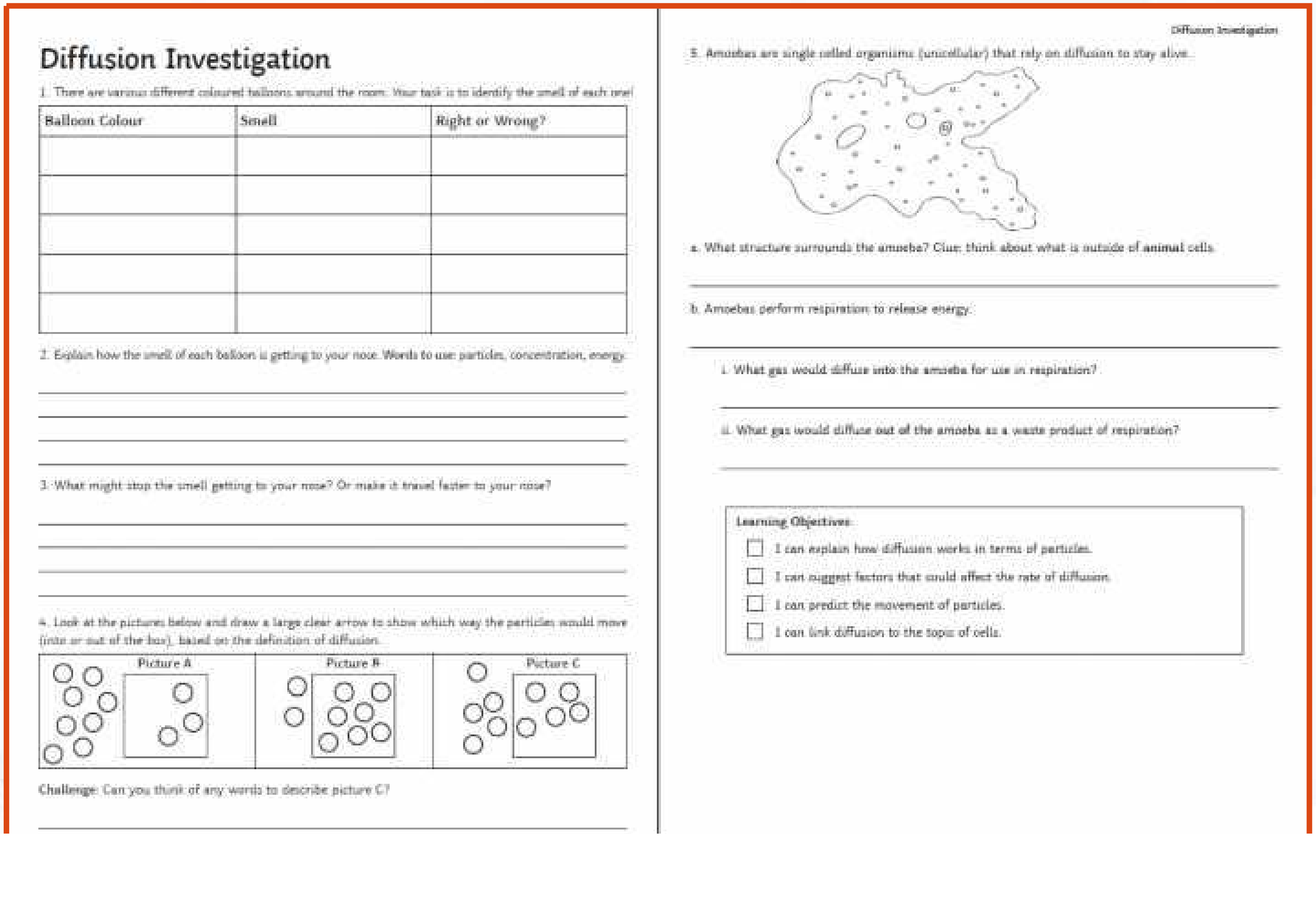
Example Responses

Diffusion is like the London Underground because the people are like **particles** and everybody is tightly packed together (**high concentration**) and then spread out (**lower concentration**) as they exit the station.

Diffusion is like a sheep pen because all of the sheep are like **particles** tightly packed in the pen (**high concentration**) and then spread out when the gate is open (**lower concentration**).

Diffusion is like riding a bike down hill because **no energy** is required (**passive process**) and it is going down a gradient.

Diffusion Activity Sheet



Diffusion Investigation

1. There are various different coloured balloons around the room. Your task is to identify the smell of each one!

Balloon Colour	Smell	Right or Wrong?

2. Explain how the smell of each balloon is getting to your nose. Words to use: particles, concentration, energy.

3. What might stop the smell getting to your nose? Or make it travel faster to your nose?

4. Look at the pictures below and draw a large clear arrow to show which way the particles would move (into or out of the box), based on the definition of diffusion.

Picture A | Picture B | Picture C

Challenge: Can you think of any words to describe picture C?

5. Amoebas are single celled organisms (unicellular) that rely on diffusion to stay alive.

a. What structure surrounds the amoeba? Clue: think about what is outside of **animal** cells.

b. Amoebas perform respiration to release energy.

i. What gas would diffuse into the amoeba for use in respiration?

ii. What gas would diffuse out of the amoeba as a waste product of respiration?

Learning Objectives:

- ☐ I can explain how diffusion works in terms of particles.
- ☐ I can suggest factors that could affect the rate of diffusion.
- ☐ I can predict the movement of particles.
- ☐ I can link diffusion to the topic of cells.

Fascinating Fact!

Earthworms don't have lungs, but still need to exchange gases for respiration!

Instead, the oxygen and carbon dioxide **diffuse** through their moist skin.

Insects have a different system and use tiny holes (spiracles) on the outside of their bodies to allow for the diffusion of gases.

Factors Affecting Diffusion

The state of matter.

Temperature.

Size of the particle.

Concentration gradient.

Factors Affecting Diffusion

The state of matter: diffusion happens quicker in gases than liquids because the particles have more kinetic energy.

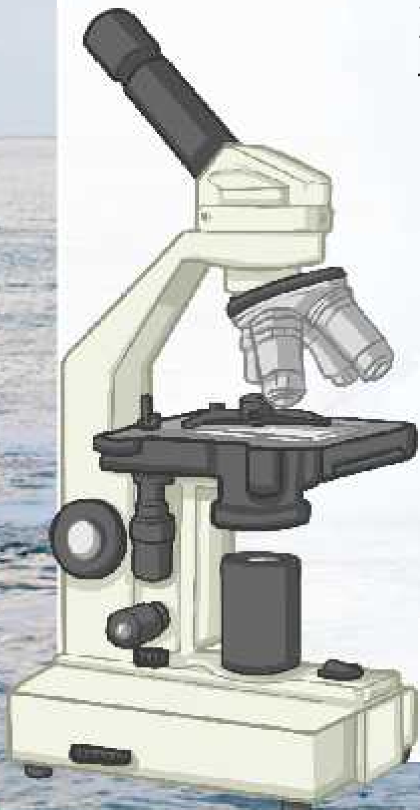
Temperature: at higher temperatures the particles have more kinetic energy and move quicker.

Size of the particle: bigger particles are heavier and take longer to move and so diffuse.

Concentration gradient: if there is a bigger difference between high and low areas, the particles will move faster.

Brownian Motion

Robert Brown was a scientist who noticed the **random** movement of pollen grains under his microscope.



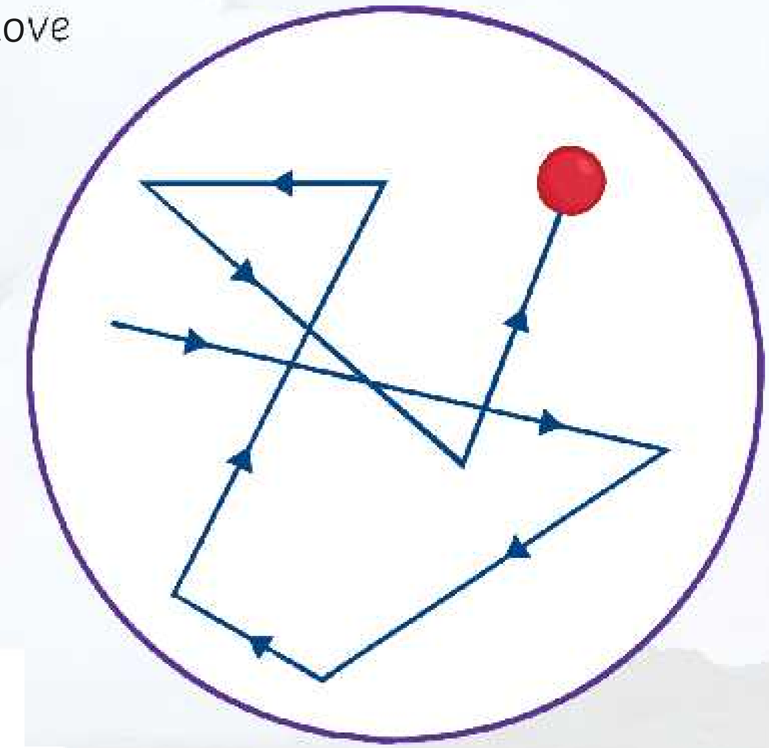
It wasn't the pollen grains themselves that were moving, but liquid or gas molecules colliding with the pollen and making it move!

This random movement of particles is known as **Brownian motion.**

Brownian Motion

This can cause diffusion to be actually a little **slower** in gases than you'd expect.

As when a big heavy particle collides with a lighter air particle, it causes it to move off in a different direction!



Plenary: Spot The Mistakes

Nikhil is telling Rebecca about diffusion.
Can you spot any mistakes in what he's said and correct them?

Diffusion is where particles move from a low to a high concentration and requires no energy to do this. It can happen in solids, liquids and gases, as the particles are free to move about. There are some factors that could affect how quickly or slowly diffusion happens. For example temperature, size of the solid, the steepness of the concentration gradient and which state of mass it is.

Plenary: Answers

Diffusion is where particles move from a **low** to a **high** concentration and requires no energy to do this. It can happen in **solids**, liquids and gases, as the particles are free to move about. There are some factors that could affect how quickly or slowly diffusion happens. For example temperature, size of the **solid**, the steepness of the concentration gradient and which state of **mass** it is.

Plenary: Answers

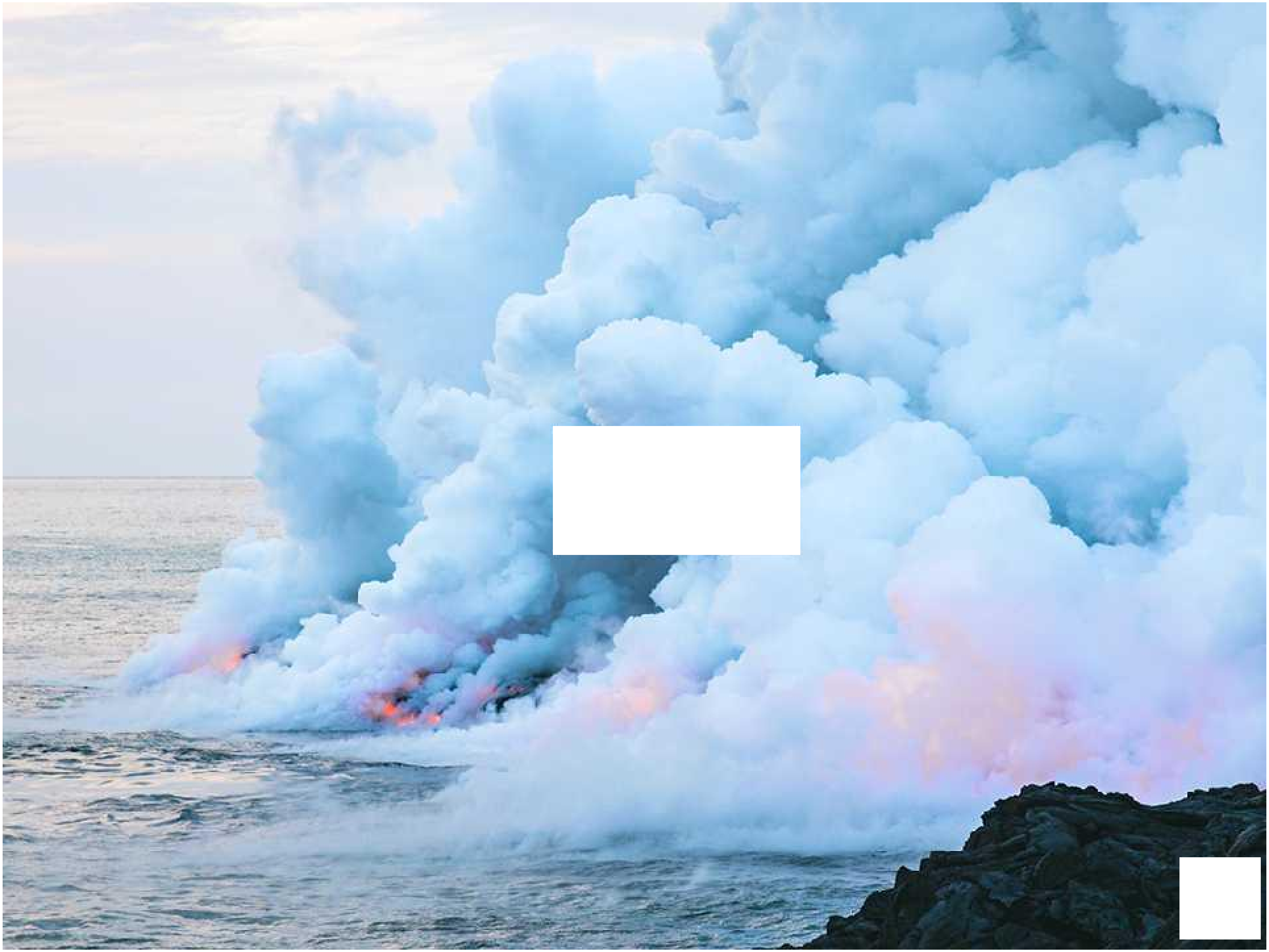
Diffusion is where particles move from a **high** to a **low** concentration and requires no energy to do this. It can happen in **liquids and gases**, as the particles are free to move about. There are some factors that could affect how quickly or slowly diffusion happens. For example temperature, size of the **particle**, the steepness of the concentration gradient and which state of **matter** it is.

What Did You Achieve Today?

I can define diffusion.

I can explain how diffusion works in terms of the particle model.

I can predict the movement of particles based on factors.



Mixtures

Aim: To visually represent the particle arrangement of air.

1. Here is a list of the components (parts) of air. Next to each identify whether it is an element or compound. Then, in the final column, write a reason why.

	Element or Compound?	Reason
nitrogen (N_2)		
carbon dioxide (CO_2)		
argon (Ar)		
oxygen (O_2)		
water (H_2O)		

2. Make sure you have sticky dots, or coloured pens to draw circles with. Each different colour will represent a different element. You must stick or draw circles to show the components of air trapped inside of a balloon, using the table above to help you. An example has been given for you:

Key:

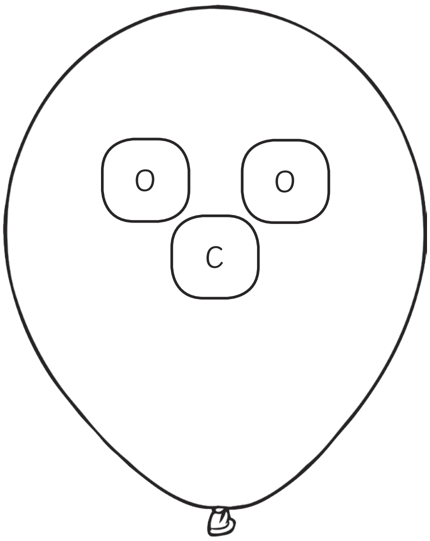
nitrogen ☐

carbon ☐

oxygen ☐

hydrogen ☐

argon ☐



3. How does the picture you've created give evidence that air is a mixture?

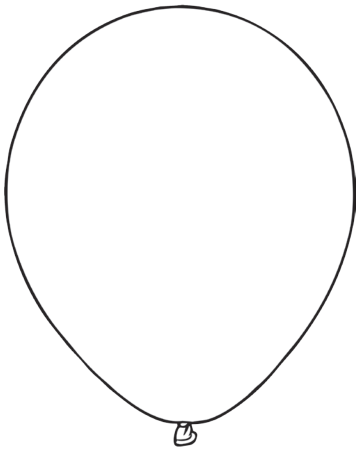
___

___

___

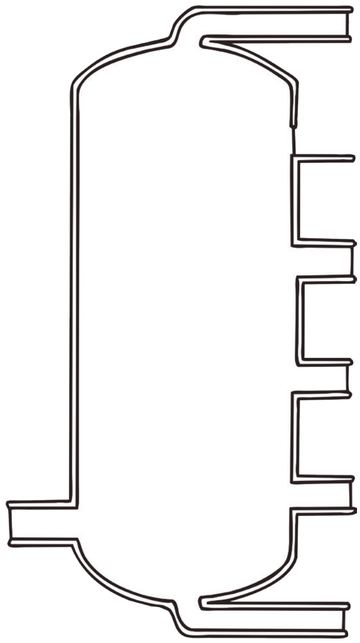
___

4. **Challenge:** If the balloon above had been filled with helium instead, how would your picture look different?



5. Some of the gases in air can be separated out using a process called fractional distillation where it is cooled to temperatures of minus 200°C!

a. What does the term 'fraction' mean to you?



b. What change of state would happen to the air at minus 200°C? **Clue:**

The **boiling** point of oxygen is -185°c and nitrogen is -196°C.

c. Why might people want to separate oxygen, in particular, from air?

Learning Objectives:

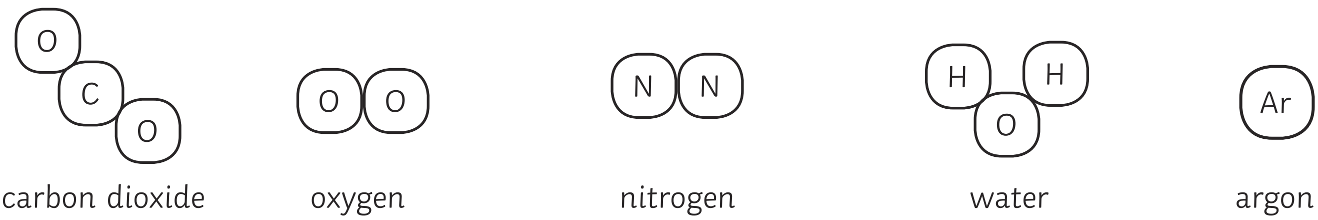
- [ ] I can identify elements and visually represent them.
- [ ] I can identify compounds and visually represent them.
- [ ] I can explain why air is a mixture using scientific terms.
- [ ] I can suggest what happens in fractional distillation and why it is carried out.

Mixtures **Answers**

1.

	Element or Compound?	Reason
nitrogen (N_2)	**element**	**Only one element present.**
carbon dioxide (CO_2)	**compound**	**Two different elements bonded together.**
argon (Ar)	**element**	**Only one element present.**
oxygen (O_2)	**element**	**Only one element present.**
water (H_2O)	**compound**	**Two different elements bonded together.**

2. Students visual representations will differ based on resources and colours available, but here is an overall idea:



3. The picture shows that there are several different substances in air that are not chemically joined/ bonded together. Each substance retains its own properties.

4. If the balloon had been filled with helium instead, the majority of the balloon would be filled with helium particles, which is an element and not a mixture. If the student has drawn their answer also in the balloon provided, there should be solely separate 'He' circles (helium is monatomic, not diatomic).

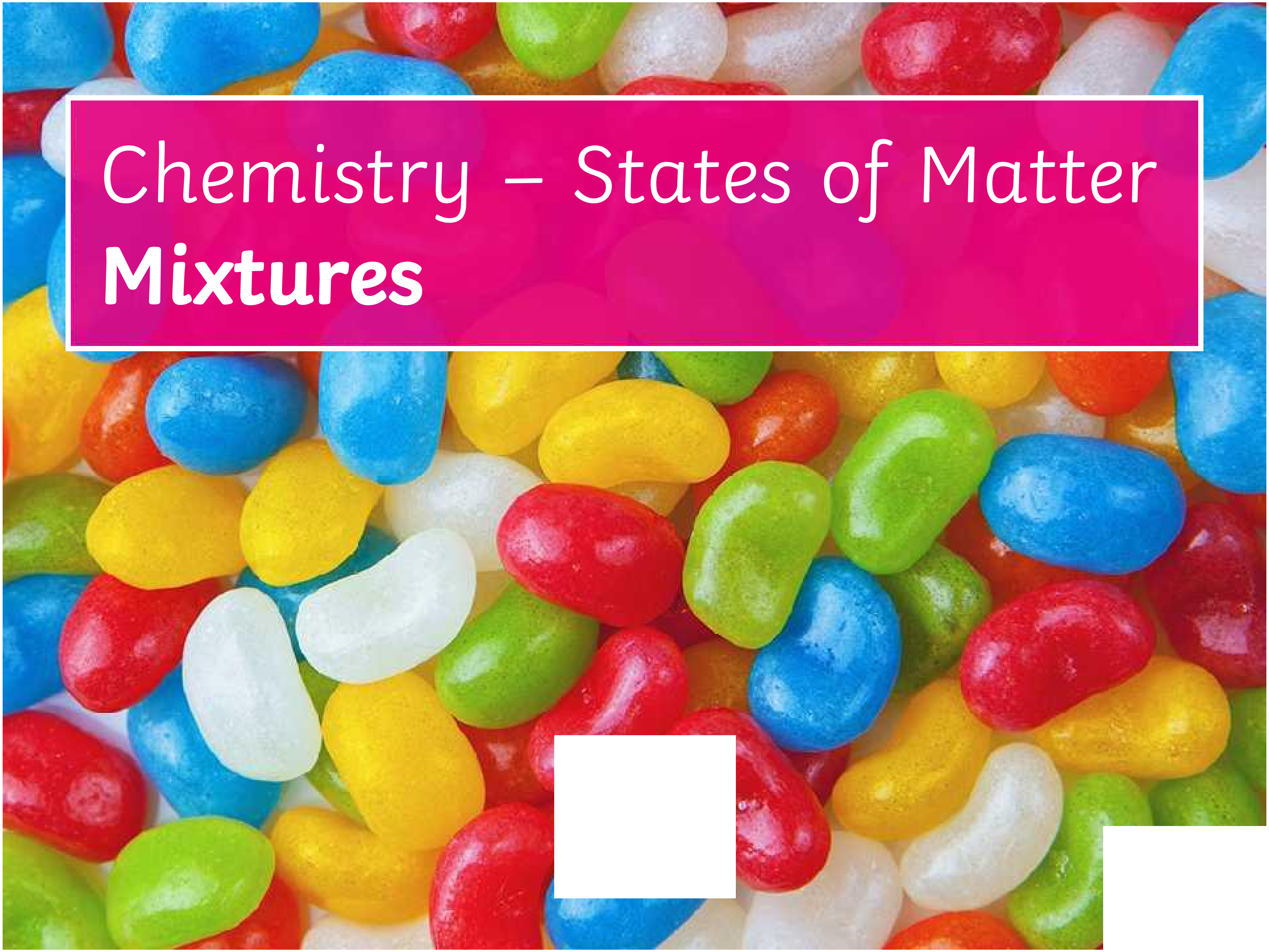
5.

a. Students answers may vary. Overall definitions of 'fraction' might include 'an amount or part of a whole' or 'a numerical quantity that is not a whole number'. For example 5/8ths or $\frac{1}{4}$.

b. At minus 200°c, oxygen and nitrogen should condense from gases into liquids.

c. People might want to separate oxygen in particular from air as it is used in burning fuels; in the manufacture of antifreeze; PVC; used in welding and cutting metals; oxygen therapy in hospitals, and treat sewage/purify water - amongst many other things! Also, emphasise that it only makes up 21% of the air, but we use it for many applications so we must separate it out.

Chemistry – States of Matter
Mixtures



Learning Objective

- To understand how mixtures look at a particle level.

Success Criteria

- To define a mixture and state examples.
- To compare mixtures to compounds.
- To model air as a mixture.

Starter

Is making a salad a chemical reaction or physical change, or both?

Making a Salad

You might **chop** ingredients for a salad.

For example, lettuce leaves.

The atoms inside of them **have not** been re-arranged.

So we call this a **physical** reaction.

Making a Salad

You might **heat** substances for a salad.

For example, boiling an egg.

The atoms inside of them **have** been re-arranged.

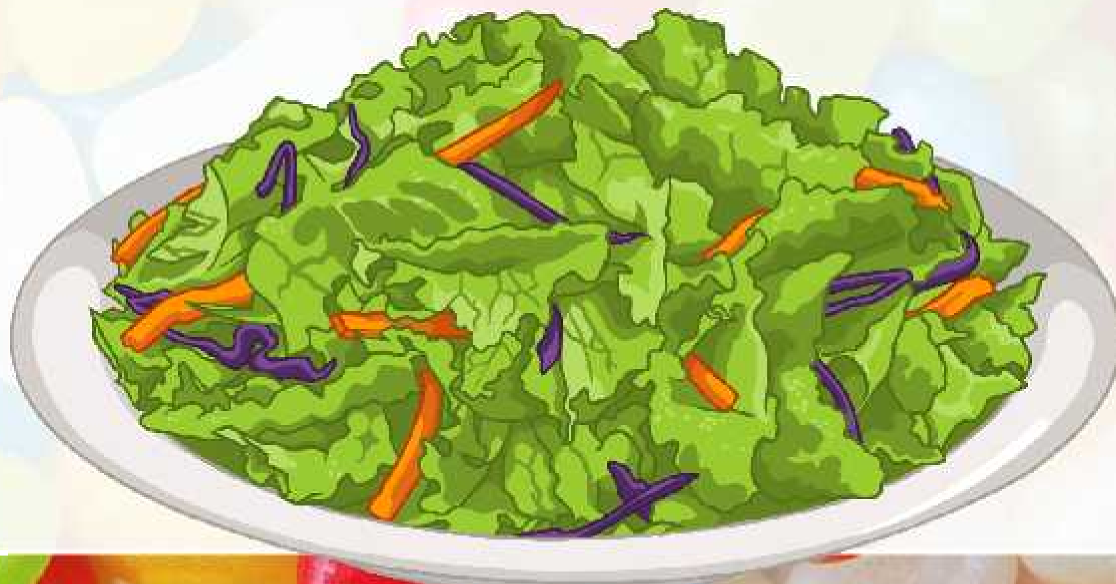
So we call this a **chemical** reaction.

Making a Salad

When you eat a **mixed** salad, the ingredients mostly **keep** their **individual taste**.

So, we say their **properties** have stayed the **same**.

Remember in science, the word **properties** means features or characteristics, not houses or buildings!



Mixtures vs Compounds: Demonstration

Iron filings are small, grey pieces of metal.

Solid sulfur is a yellow powder.

Watch as we **mix** them.

Is this a chemical reaction or physical change?

Photo courtesy of oskay, via Flickr

Mixtures vs Compounds: Demonstration

Iron filings are small, grey pieces of metal.

Solid sulfur is a yellow powder.

Watch as we **heat** them.

Photo courtesy of oskay, via Flickr

Is this a chemical reaction or physical change?

Mixtures vs Compounds: Demonstration

When the iron filings and sulfur powder were stirred together, you could **easily separate** them with a magnet.

They still had their **own** individual colour and **properties**. The **atoms** had **not** been **re-arranged**.

So this was a **physical** change.

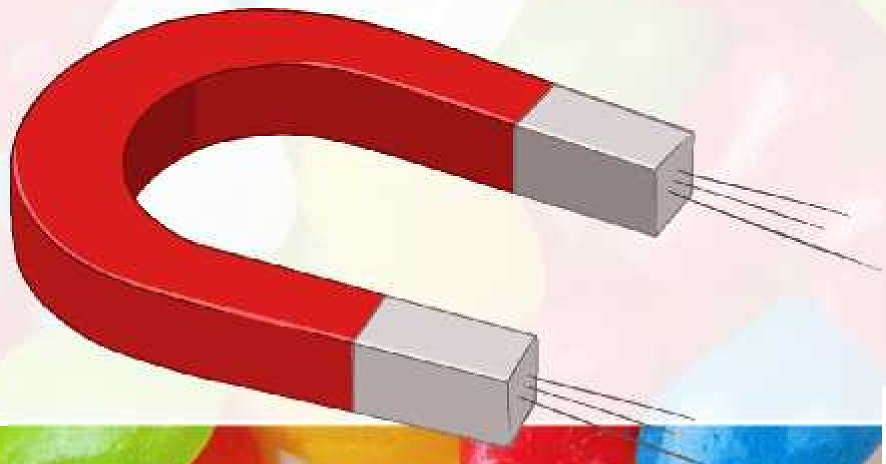


Photo courtesy of Asoult, via Wikimedia Commons

Mixtures vs Compounds: Demonstration

When the iron filings and sulfur powder were heated together, you could **not separate** them with a magnet.

The yellow colour disappeared and a dark metal solid was formed, with different **properties**. The **atoms had** been **re-arranged and bonded together**.

So this was a **chemical** reaction.

Mixtures: Definition

A mixture contains ___________ or more substances that are not ___________ joined together (b___________).

The substances keep their own ___________.

You can (usually) easily __________ them using __________ methods.

Mixtures: Definition

A mixture contains ____________ or more substances that are not ____________ joined together (b____________).

The substances keep their own ____________.

You can (usually) easily ___________ them using ___________ methods.

Key Words: physical, bonded, chemically, two, separate, properties.

Mixtures: Definition

A mixture contains t__________ or more substances that are not c__________ joined together (b___________).

The substances keep their own pr___________.

You can (usually) easily s__________ them using ph________ methods.

Key Words: physical, bonded, chemically, two, separate, properties.

Mixtures: Definition

A mixture contains **two** or more substances that are not **chemically** joined together (**bonded**).

The substances keep their own **properties**.

You can (usually) easily **separate** them using **physical** methods.

Challenge: Can you make your own definition of a compound using the same structure above?

Compounds: Definition

A **compound** contains two or more **elements** that **are chemically** joined together (**bonded**).

A compound has **different** properties to it’s individual elements.

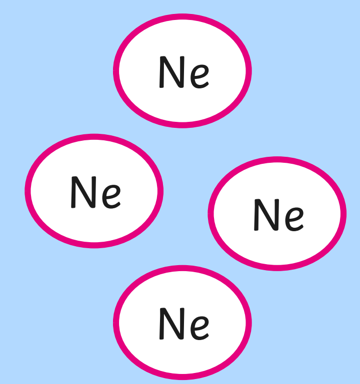
You can **separate** them using **chemical** reactions.

Identifying Activity

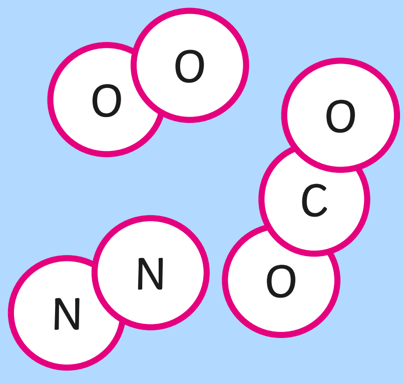
Look at each picture.

In pairs, can you guess which are elements, compounds or mixtures?

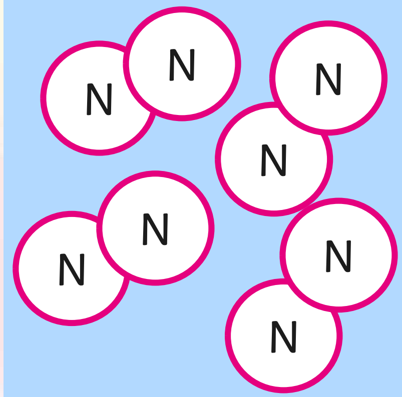
Picture A



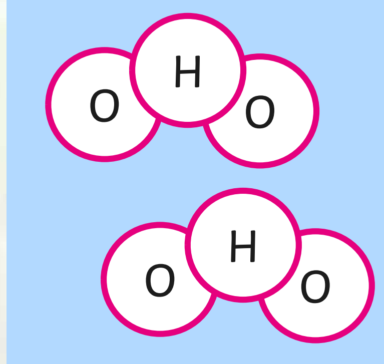
Picture B



Picture C



Picture D



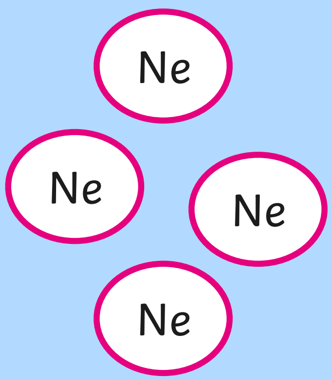
Challenge: Can you name any of these elements, compounds or mixtures?

Identifying Activity: Answers

Look at each picture.

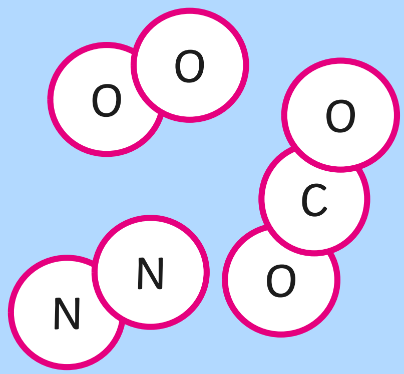
In pairs, can you guess which are elements, compounds or mixtures?

Picture A



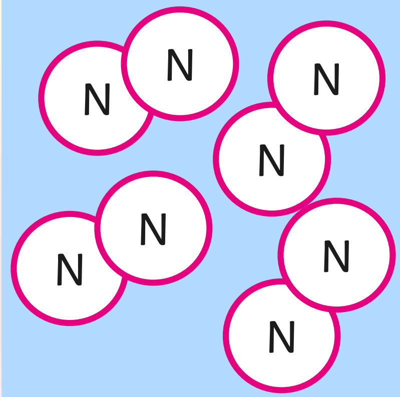
element (neon)

Picture B



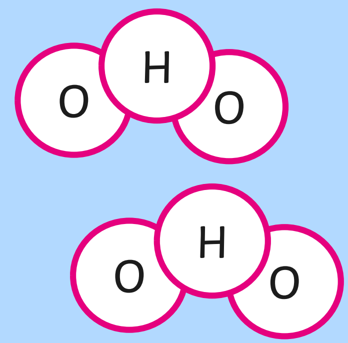
mixture (air)

Picture C



element (nitrogen)

Picture D



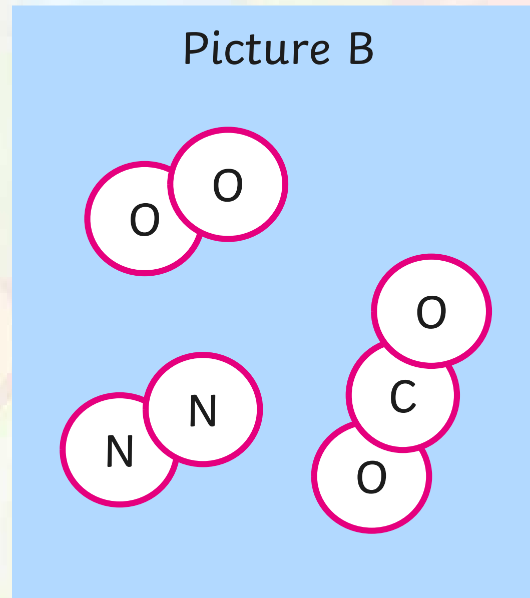
compound (water)

Air as a Mixture

Picture B represented some of the main parts of air.

Within the mixture of air, there are **also** elements and compounds.

Can you identify them?



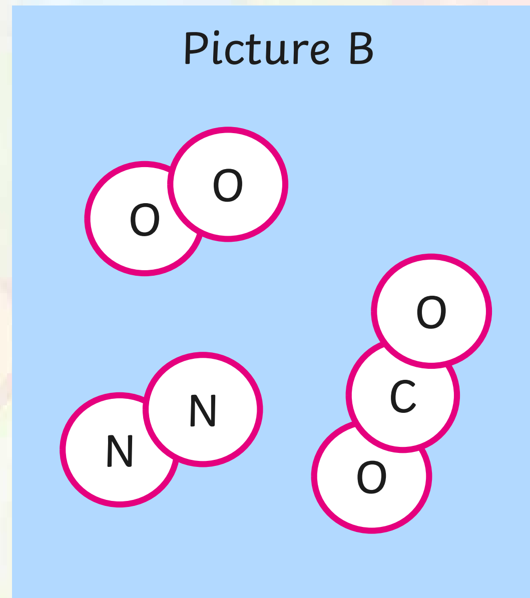
Air as a Mixture

Picture B represented some of the main parts of air.

Within the mixture of air, there are **also** elements and compounds.

Can you identify them?

Oxygen and nitrogen are elements. Carbon dioxide is a compound.



Fascinating Fact!

Some atoms exist in pairs, like oxygen and nitrogen. We call these ‘**diatomic**’ from the Greek word for ‘two’ or ‘double’.

More Mixtures

seawater

mud

concrete

water and oil

By Victor Blacus , via Wikimedia Commons

Explanation Activity

seawater

mud

concrete

water and oil

In pairs, take it in turns to explain why each of the four examples on the left are mixtures.

Score your friends answers out of ten based on:

- how many keywords they used;
- whether they used their notes to help.

By Victor Blacus , via Wikimedia Commons

Plenary: Alloys

Alloys are substances made up of at least one metal, sometimes two, to give greater strength or lower melting points.

Nitinol is made from nickel and titanium.

It is used in the frames of glasses as when this metal is bent out of shape, you can use heat to return it to the original shape!

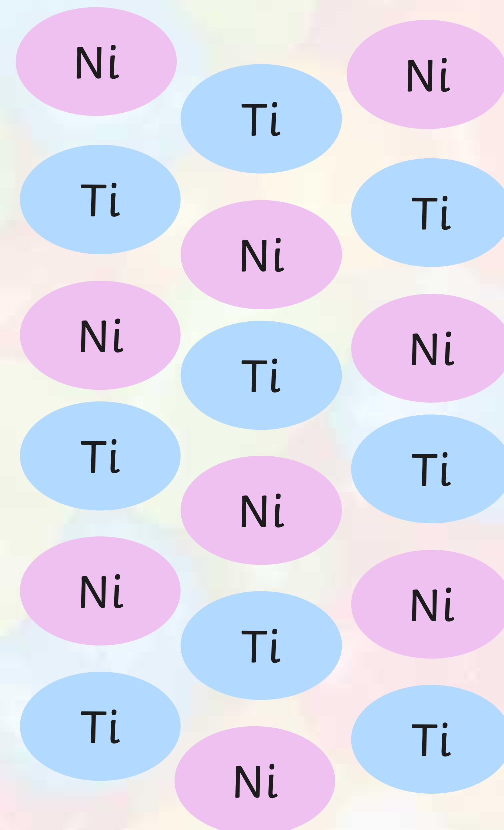
By Petermaerki, via Wikimedia Commons

Plenary: Alloys

Here is a basic picture of the particles inside of nitinol (made from nickel and titanium).

Is nitinol an element, compound or mixture?

Explain your answer.



What Did You Achieve Today?

- I can define a mixture and state examples.
- I can compare mixtures to compounds.
- I can model air as a mixture.

Mixtures Quick Assessment

1. What is a mixture?

____

____

____

____

2. List three examples of mixtures:

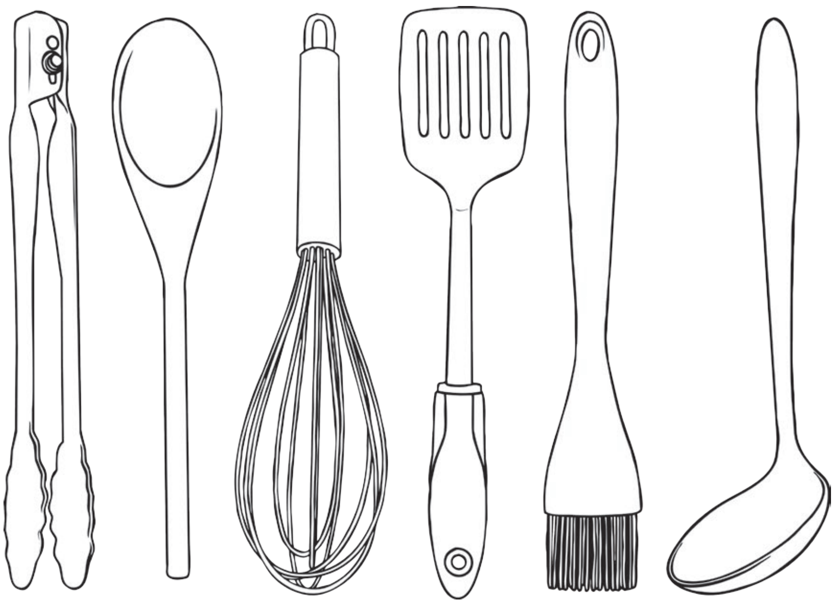
a. ____________________ b. ____________________ c. ____________________

3. Complete the table to compare mixtures to compounds:

	Mixture	Compound
Are the substances chemically bonded together?		
Do the substances keep their individual properties?		
How would you separate them?		
Can you increase or decrease the amounts of each substance?		

4. Aman follows this recipe for making a cake.

1. Pre-heat the oven to 180°c.
2. Melt 100g of butter in a saucepan.
3. Add 100g of sugar to the butter and stir well.
4. Sift in 100g of flour.
5. Crack open two eggs into the pan and beat them well.
6. Add a drop of vanilla extract.
7. Spoon into cupcake cases.
8. Place in the oven for twenty minutes.



a. At which point is the cake a mixture?

b. Explain your answer:

c. When is it **not** a mixture?

d. Explain your answer:

Challenge: Include the terms 'bonding', 'properties' and 'atoms' in your answer.

Learning Objectives:

- [ ] I can define a mixture.
- [ ] I can list examples of mixtures.
- [ ] I can compare mixtures to compounds.
- [ ] I can apply my knowledge to new situations.

Mixtures Quick Assessment **Answers**

1. A mixture is two or more substances that are not chemically joined/bonded together. Each substance retains its own properties. You can (usually) easily separate them using physical methods.

2. Answers could include: iron filings and sulphur, air, oil and water, concrete, seawater and mud.

	Mixture	**Compound**
Are the substances chemically bonded together?	**no**	**yes**
Do the substances keep their individual properties?	**yes**	**no**
How would you separate them?	**physical processes**	**chemical reactions**
Can you increase or decrease the amounts of each substance?	**yes**	**no**

4.

a. The cake is a mixture until the final step.

b. This is because the atoms have not been chemically joined together/bonded and therefore not re-arranged. The substances still have their own properties and identities.

c. The final step is when the cake is **not** a mixture.

d. This is because the heat of the oven has caused a chemical reaction and **bonded** the **atoms** together and re-arranged them. The cake now has different **properties** (taste) to the original components.

Mixtures Quick Assessment **Teacher Feedback Sheet**

Effort: 1 2 3 4 5

You can define a mixture using **some** keywords.	You can define a mixture using **most** keywords.	You can define a mixture using **all** keywords.
You can name **one** example of a mixture.	You can name **two** scientific mixtures.	You can name **three** or more scientific mixtures.
You can compare **some** ways mixtures are different to compounds.	You can compare **most** ways mixtures are different to compounds.	You can compare **all** ways mixtures are different to compounds.
With **guidance**, you can **categorise** whether a substance is an element, mixture or a compound mixture based on information given.	With **guidance**, you can **categorise** and **justify** whether a substance is an element, mixture or a compound mixture based on information given.	You can **independently categorise** and **justify** whether a substance is an element, mixture or a compound mixture based on information given.

Next Steps:

Mixtures
Teaching Ideas

Learning Objective: To understand how mixtures look at a particle level.

Success Criteria:

- To define a mixture and state examples.
- To compare mixtures to compounds.
- To model air as a mixture.

Context: This is the fifth lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Starter

On slide 3 is a picture of a salad alongside the question, 'Is making a salad a chemical reaction or physical change?' This allows students to draw upon their knowledge of an everyday situation, and for the teacher to gauge their understanding of chemical and physical reactions.

Main Activities

Making a Salad

Slides 4-6: Remind students of the differences between chemical reactions and physical changes using the concept of making a salad. There are some physical reactions in preparing a salad and the example of chopping lettuce is given on slide 4. There can also be some chemical reactions, depending on the ingredients in the salad, and an example of boiling an egg is given on slide 5. The notion of eating a mixed salad, but the ingredients retaining their taste and therefore properties, is given on slide 6. A reminder of the science definition of properties is also given on slide 6.

Mixtures vs Compounds: Demonstration

Slides 7-10: Students are introduced to the classic demonstration of iron filings and sulfur on slide 7. **Teacher note – eye protection should be worn for this demonstration**. Mix a small amount of iron filings with sulfur powder in a container, then raise a magnet above it – the iron filings are easily separated out. Ask the students whether this is a chemical reaction or a physical change. Then, place the iron filings and sulfur in a test tube and heat it gently using a Bunsen burner. Show the students the end product and ask the students whether this is a chemical reaction or a physical change. The explanations for each demonstration are given on slides 9 and 10.

Mixtures: Definitions

Slides 11-15: Students are given a cloze style activity to complete on slide 11, and more prompts are given on slide 12 and 13. You can choose the level of help you think your students will need. This is useful to note down the key points about mixtures covered so far in today's lesson. The answers are shown on slide 14, alongside an extension task which asks students to create their own definition of a compound. This is based on the same structure as the definition of a mixture. The answer is shown on slide 15.

Identifying Activity

Slides 16-17: Students work in pairs to apply their understanding of the definitions to the four particle pictures on slide 16. They must work out whether each picture is an element, compound or mixture. An extension question is also shown asking students to name any of the pictures scientifically, e.g. neon. Periodic tables could be used for support. The answers are given on slide 17.

Air as a Mixture

Slides 18-19: Introduce students to the notion that mixtures can contain elements and compounds within them, and air is an example of this. Students may have already identified the elements oxygen and nitrogen, and the compound carbon dioxide, in the previous slide. Answers are given on slide 19.

More Mixtures and Explanations

Slides 20-21: Show students slide 20 with four more examples of mixtures and pictures alongside them. These include seawater, mud, concrete, and water and oil. Ask students to work in pairs, alternating between them, to verbally explain why each of these is a mixture. Students peer assess each other's answers out of ten based on how many keywords they used and whether they referred back to their notes for additional support.

Mixtures Activity Sheet

Students follow the worksheet to firstly identify the components of air as elements or compounds, and then to create a visual representation of air as a mixture. This can be done by using either sticky dots or coloured pens as atoms of each element. Students then use their picture to justify why air is classed as a mixture, and then compare it to a balloon with solely helium inside. Extension questions are given about the fractional distillation of air.

Mixtures Quick Assessment Sheet

Students follow the worksheet to demonstrate their knowledge of mixtures by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Alloys

Slide 22: Show students the background information about the smart memory alloy nitinol. Then ask students to use their knowledge from today to look at the picture on slide 23, and consider whether nitinol is an element, compound or mixture. Nitinol is a mixture containing two elements, but they are not chemically bonded together. Answers could be written in books for formative assessment, discussed as a class or written on mini whiteboards. Remind the students of today's success criteria on slide 24 of the PowerPoint.

Suggested Home Learning

Students could produce a research poster on the steps involved in the fractional distillation of air and its subsequent uses.

Planning an Experiment into Solubility **Answers**

1. Background Information:

When a substance is dissolved into a liquid, we call the substance dissolving a **solute**, the liquid a **solvent**, and the mixture formed is called a **solution**.

We are going to plan an experiment to see how much solute dissolves at different temperatures, this is known as **solubility**. If we keep adding the solute and no more dissolves, then the solution is fully **saturated**.

2. Method:

a. Clear a suitable working area, tie long hair up and put on safety goggles.

b. Fill a glass beaker with 25ml of sugar (solvent) at room temperature.

c. Add 10g of sugar (solute) at a time, noting down how much you have added.

d. Stir gently with a glass rod, applying the same amount of force each time.

e. Keep adding the solute until no more dissolves and the solution is fully saturated and record the total amount of grams of solute added.

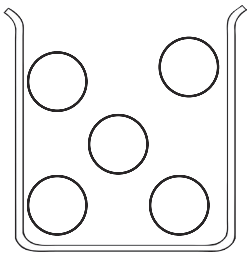
f. Repeat steps b to d with hotter water. The temperatures we will use are 50°C and 100°C.

Students completing the higher ability worksheet may have used different temperatures.

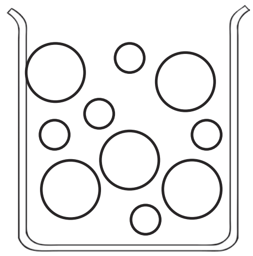
3. How the Particles Look Inside

Draw two beakers showing the particles inside of them.

Beaker A (water only)



Beaker B (water and solute)



4. Risk Assessment

Complete the table to consider any safety issues in this practical. The first one has been given as an example.

Hazard	Harm	How You Will Prevent Injuries
glass beaker	Could break and cut skin.	Keep floor clear and hold beaker securely; place in middle of table; wear goggles.
hot water	Could scold or burn skin.	Keep floor clear and hold beaker securely; place in middle of table; cover arms if possible.
water	Could spill on floor and slip over.	Mop up any spillages straight away and inform others.
thermometer	Could break and cut skin.	Hold thermometer securely and return when not in use so it cannot roll off the table; use a glass stirring rod to mix the sugar.

5. Variables:

a. What are you changing (the independent variable)?

The temperature of the water (solvent).

What are the units?

degrees celsius (°c)

b. What are you measuring (the dependent variable)?

The mass of the sugar (solute).

What are the units?

grams (g)

c. What will you keep the same (the control variables)?

- **The volume of the solvent/water (25ml);**
- **the time and speed of stirring the solution;**
- **the type of solute and solvent being used.**

Prediction:

Students should predict that the hottest temperature they have planned to use will have the highest solubility of sugar into water. This will normally be 100°C in most plans.

This is because of the kinetic energy of the water particles at higher temperatures. These collide with the sugar at higher rates, therefore breaking the bonds between the bigger pieces and allowing them to dissolve.

Planning an Experiment into Solubility **Peer Feedback**

Effort: 1 2 3 4 5

Name of person reading your work: ______________________________

- **What Went Well? (WWW)**

____

____

____

____

- **Even Better If? (EBI)**

____

____

Signed by peer: **Dated:**

Planning an Experiment into Solubility **Teacher Feedback**

Effort: 1 2 3 4 5

With **guidance**, you can write a background paragraph using **some** keywords correctly.	You can **independently** write a background paragraph using **most** keywords.	You can **independently** write a background paragraph using **all** keywords.
With **guidance**, you can write a basic plan to collect results safely.	You can **independently** write a plan to collect results safely.	You can **independently** write a plan to collect valid results safely.
You can identify **some** risks in an experiment and state how they could harm you.	You can identify **most** risks in an experiment, state how they could harm you and state some general prevention methods.	You can identify **all** risks in an experiment, state how they could harm you and state some personalised prevention methods.
With **guidance**, you can state the factor you are changing and what you are measuring.	You can **independently** state the independent and dependent variable and with **guidance** state some control variables.	You can **independently** state the independent, dependent and control variables and suggest how to monitor the controls.
With **guidance**, you can state a basic prediction.	You can **independently** write a prediction.	You can **independently** write a prediction and explain the science behind your idea.

Next Steps:

Planning an Experiment into Solubility

1. Background Information:

Words to use: solution, saturated, solute, solvent.

When a substance is dissolved into a liquid, we call the substance dissolving a s_______________, the liquid a s_________________, and the mixture formed is called a s______________________.

We are going to plan an experiment to see how much solute dissolves at different temperatures, this is known as **solubility**. If we keep adding the solute and no more dissolves, then the solution is fully s___________________.

2. Method:

a. Clear a suitable working area, ______________ long hair up and put on safety goggles.

b. Fill a glass beaker with 25ml of ___________________ (solvent) at room temperature.

c. Add 10g of ___________________ (solute) at a time, noting down how much you have added.

d. Stir gently with a ___________________, applying the same amount of force each time.

e. Keep adding the solute until no more dissolves and the solution is fully s___________________ and record the total amount of grams of solute added.

f. Repeat steps b to d with hotter water. The temperatures we will use are 50°C and 100°C.

3. How the Particles Look Inside:

Draw two beakers showing the particles inside of them.

Beaker A (water only) **Beaker B (water and sugar)**

4. Risk Assessment:

Complete the table to consider any safety issues in this practical. The first one has been given as an example.

Hazard	Harm	How You Will Prevent Injuries
glass beaker	Could break and cut skin.	Keep floor clear and hold beaker securely; place in middle of table; wear goggles.

5. Variables:

a. What are you changing (the independent variable)?

____

What are the units? ______________________________

b. What are you measuring (the dependent variable)?

____

What are the units? ______________________________

c. What will you keep the same (the control variables)?

____

____

____

____

6. Prediction:

My prediction is... (**Hint:** Which temperature do you think the most amount of sugar will dissolve in?)

____

____

I think this because... (What is the science behind this idea?)

____

____

Planning an Experiment into Solubility

1. Background Information

Use the space below to write an introductory paragraph about solutions.

Words to use: solution, saturated, solute, solvent, solubility.

2. Method

Use the space below to write a clear method for adding 10g of solute at a time to a 25ml beaker of room temperature water until it is fully saturated. Then repeat with different temperatures of your choice.

3. How the Particles Look Inside

Draw two beakers showing the particles inside of them.

Beaker A (water only) **Beaker B (water and solute)**

4. Risk Assessment

Complete the table to consider any safety issues in this practical. The first one has been given as an example.

Hazard	Harm	How You Will Prevent Injuries
glass beaker	Could break and cut skin.	Keep floor clear and hold beaker securely; place in middle of table; wear goggles.

5. Variables

a. The independent variable is: ______________________________

b. The dependent variable is: ______________________________

c. Some control variables are:

____

____

____

____

d. How we will monitor them:

____

____

____

____

6. Prediction

I predict that ______________________________

____

____

I think this because (What is the science behind this idea?) ______________________________

____

____

Chemistry States of Matter
Solubility

Learning Objective

- To plan an investigation on solubility.

Success Criteria

- To define keywords.
- To apply keywords to situations.
- To design a safe and valid experiment.
- To describe how temperature affects solubility.

Starter

A Nice Cup of Tea

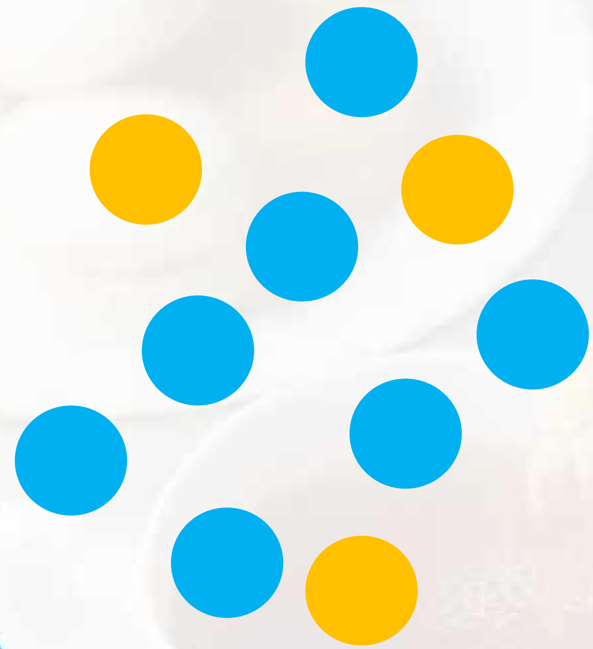
When you add sugar to a cup of tea what happens...

- to the sugar?
- to the mass of the tea?
- if the tea is made with colder water?

Adding Sugar to Water

When you add sugar to a cup of tea, the sugar **dissolves**, it doesn't disappear!

The particles of **sugar** are **added** to the particles of **water**, so the **mass** increases.

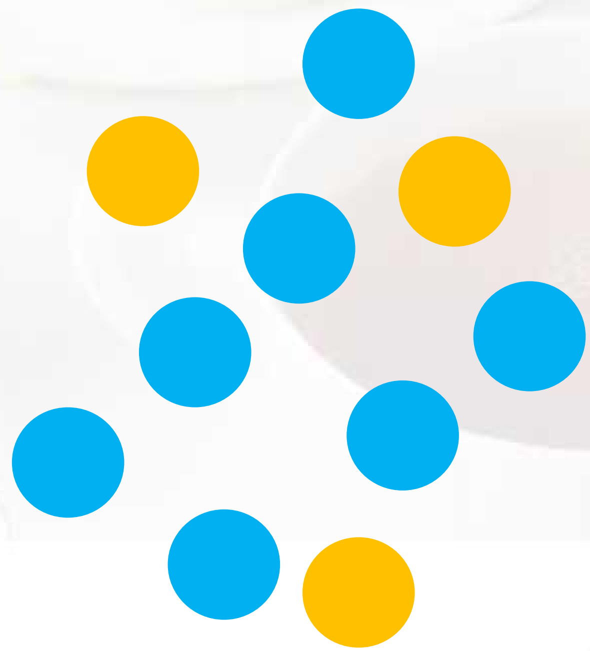


Adding Sugar to Water

When you add sugar to **colder** water, it takes **longer** to dissolve, if at all!

Think back to how particles are arranged in a **liquid**.

Why might it take longer if the water is colder?

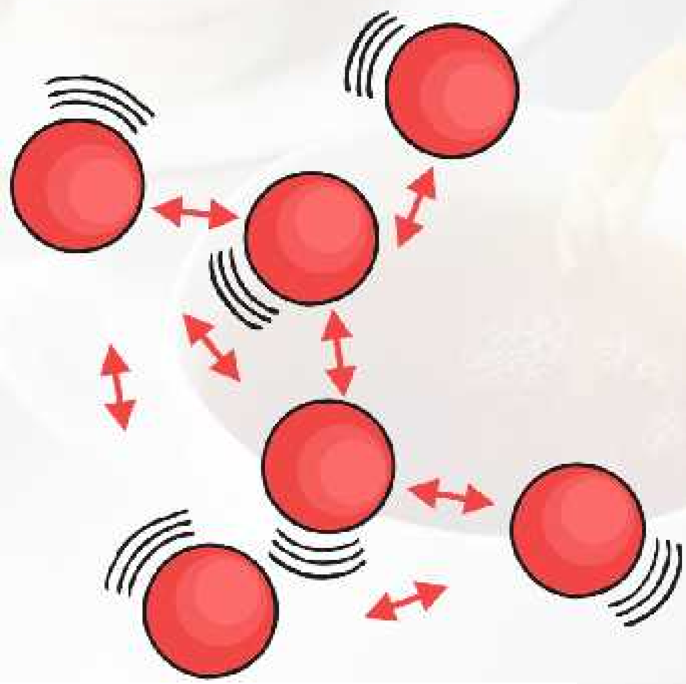


Adding Sugar to Water

When water is colder, the particles are moving more slowly.

When water is **hotter**, the particles are moving ***faster*** - they have more ***kinetic*** energy.

This means when they collide with the sugar, the bonds within the sugar cube are more easily broken.

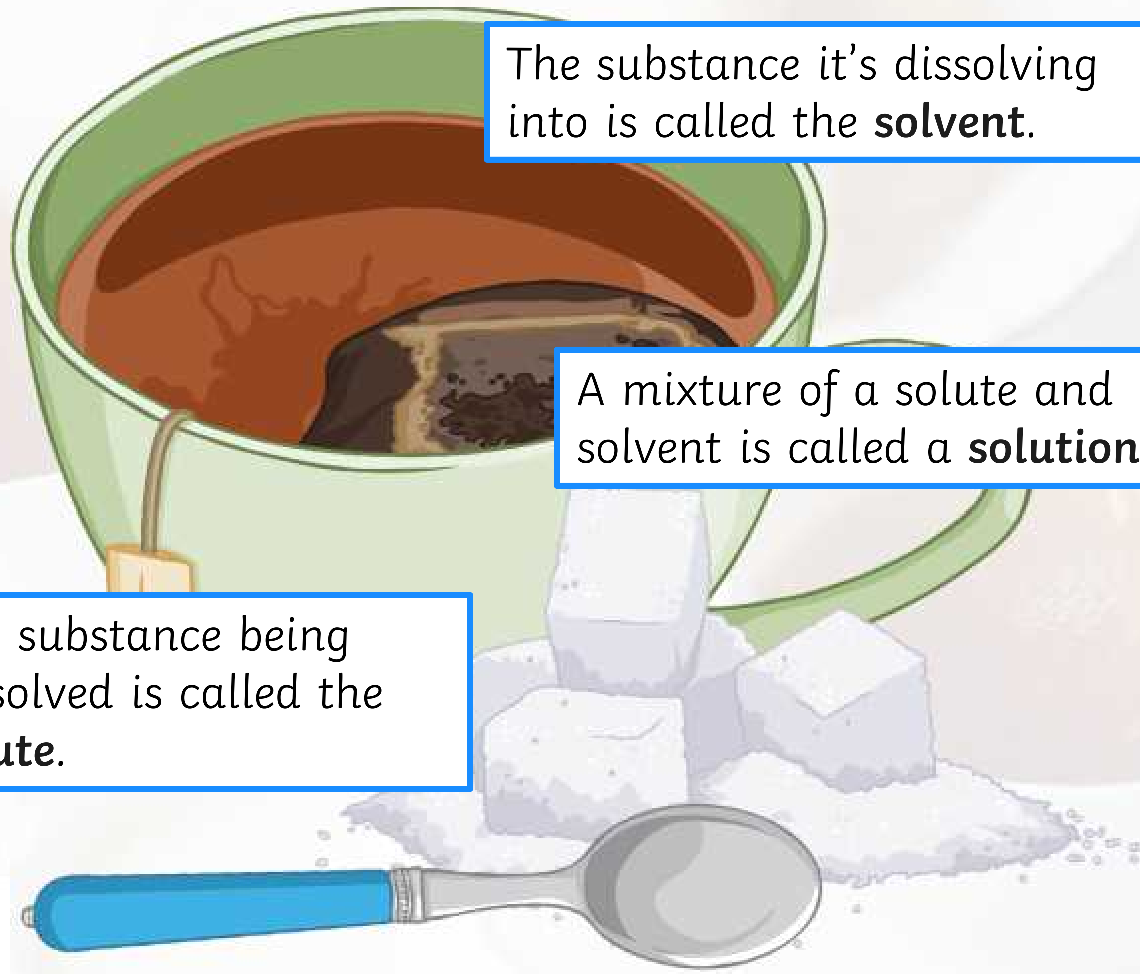


Keywords Activity

- The substance being dissolved is called the **solute**.
- The substance it's dissolving into is called the **solvent**.
- A mixture of a solute and solvent is called a **solution**.

Can you draw a quick sketch of a cup of tea and write these definitions in the correct place?

Answers



The substance it's dissolving into is called the **solvent**.

A mixture of a solute and solvent is called a **solution**.

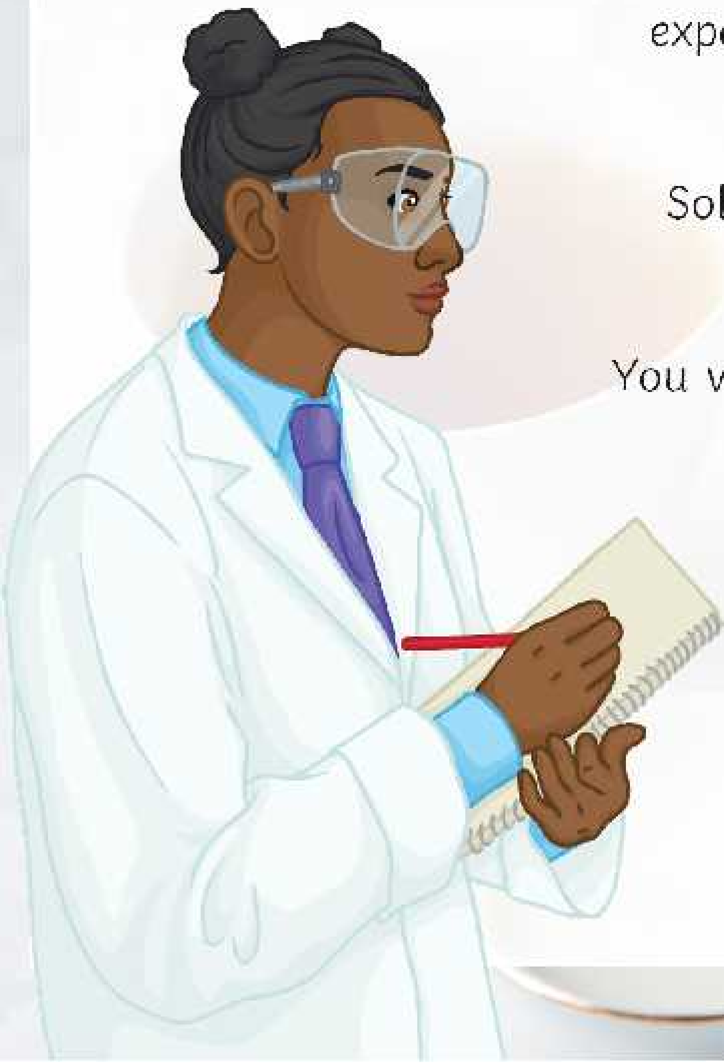
The substance being dissolved is called the **solute**.

Keywords: Extra

If you kept adding sugar to water, it would reach a point where no more could dissolve. We say the solution is **saturated**.

If you added sand to water, it would not dissolve. We say substances like these are **insoluble**.

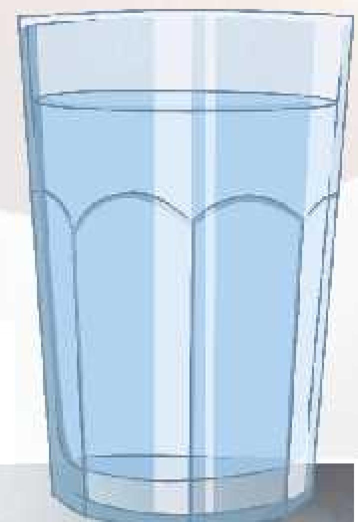
Planning an Experiment



You are going to plan a safe and valid experiment into the solubility of sugar (the solute) in water.

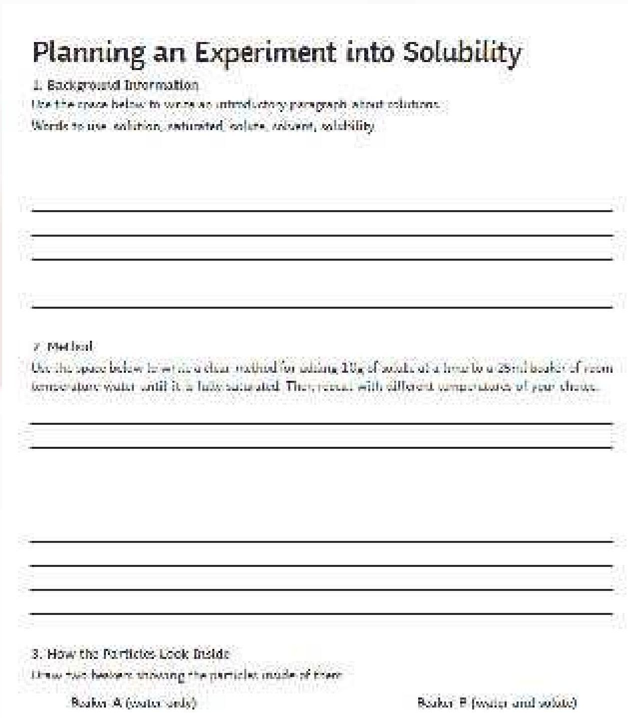
Solubility is a measure of how much solute will dissolve.

You will record how much sugar dissolves at different temperatures.



Activity Sheet

Now follow the activity sheet to plan your experiment.



Planning an Experiment into Solubility

1. Background Information

Use the space below to write an introductory paragraph about solutions.

Words to use: solution, saturated, solute, solvent, solubility

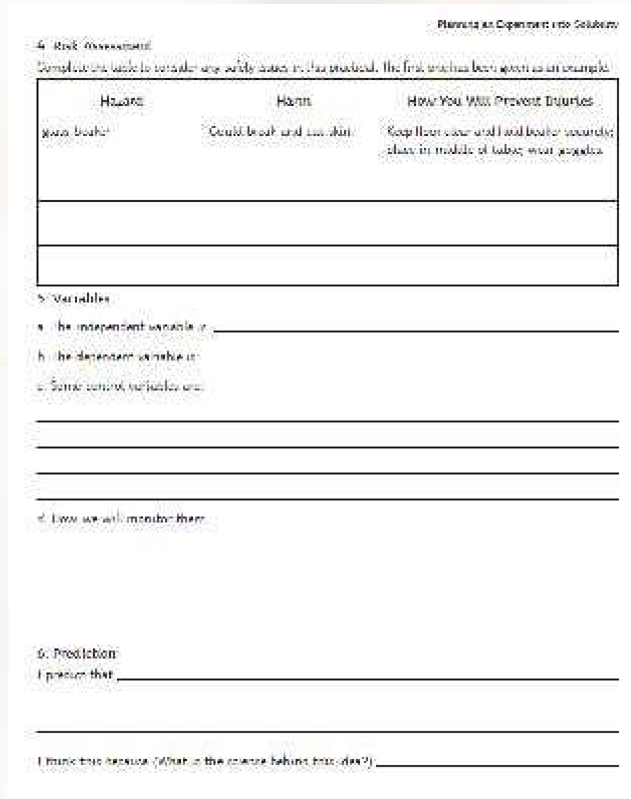
2. Method

Use the space below to write a clear method for adding 10g of solute at a time to a 25ml beaker of room temperature water until it is fully saturated. Then repeat with different temperatures of your choice.

3. How the Particles Look Inside

Draw two beakers showing the particles inside of them.

Beaker A (water only) Beaker B (water and solute)



4. Risk Assessment

Complete the table to consider any safety issues in this practical. The first one has been given as an example.

Hazard	Harm	How You Will Prevent Injuries
glass beaker	Could break and cut skin	Keep floor clear and hold beaker securely; place in middle of table; wear goggles

5. Variables

a. The independent variable is:

b. The dependent variable is:

c. Some control variables are:

d. How we will monitor them:

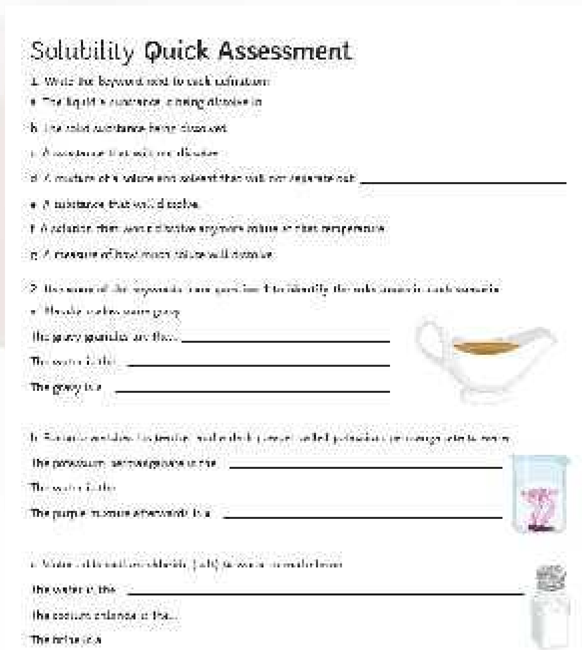
6. Prediction

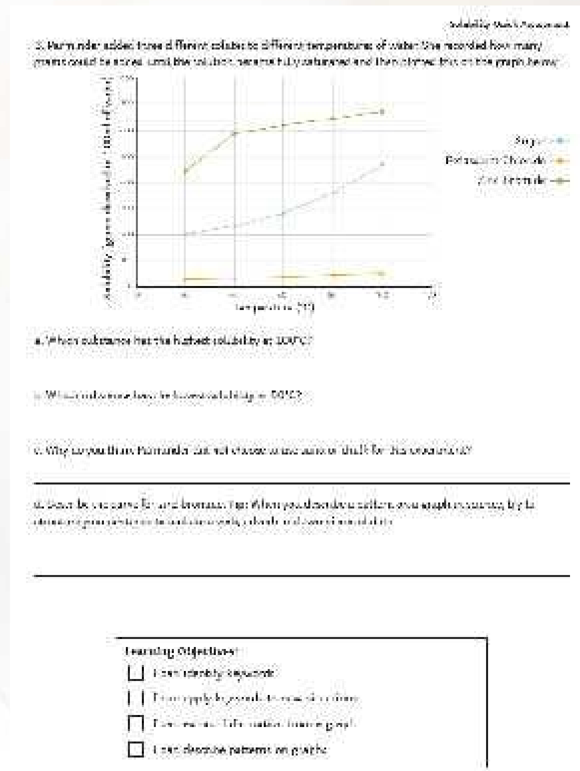
I predict that

I think this because (What is the science behind this idea?):

Quick Assessment Sheet

Now complete the assessment sheet to show your understanding of today's lesson.



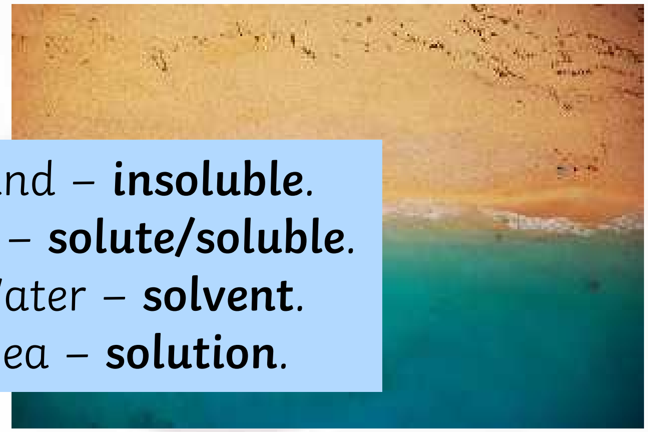


Plenary: Spot the Keyword

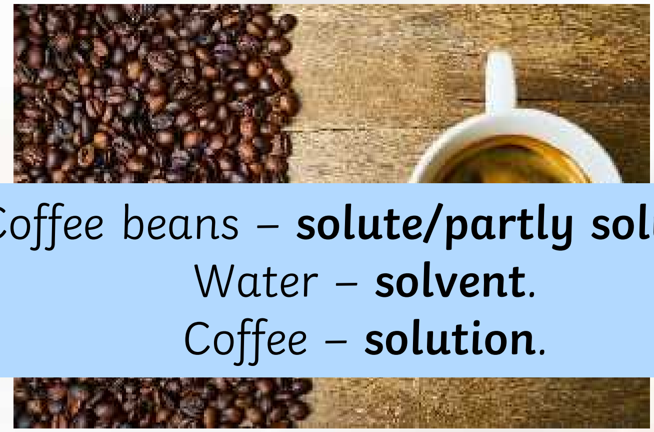
How many keywords from today can you spot in these pictures?

Plenary: Spot the Key Word

How many keywords from today can you spot in these pictures?



Sand – **insoluble**.
Salt – **solute/soluble**.
Water – **solvent**.
Sea – **solution**.



Coffee beans – **solute/partly soluble**.
Water – **solvent**.
Coffee – **solution**.

Bath bomb – **solute/soluble**.
Bath water – **solvent**.
Bath with salts – **solution**.

What Did You Achieve Today?

- I can define key words.
- I can apply key words to situations.
- I can design a safe and valid experiment.
- I can describe how temperature affects solubility.

Solubility **Quick Assessment**

1. Write the keyword next to each definition:

a. The liquid a substance is being dissolved in. ______________________________

b. The solid substance being dissolved. ______________________________

c. A substance that will not dissolve. ______________________________

d. A mixture of a solute and solvent that will not separate out. ______________________________

e. A substance that will dissolve. ______________________________

f. A solution that won't dissolve anymore solute at that temperature. ______________________________

g. A measure of how much solute will dissolve. ______________________________

2. Use some of the keywords from question 1 to identify the substances in each scenario.

a. Klaudia makes some gravy.

The gravy granules are the... ______________________________

The water is the... ______________________________

The gravy is a... ______________________________

b. Romario watches his teacher add a dark powder called potassium permanganate to water.

The potassium permanganate is the... ______________________________

The water is the... ______________________________

The purple mixture afterwards is a... ______________________________

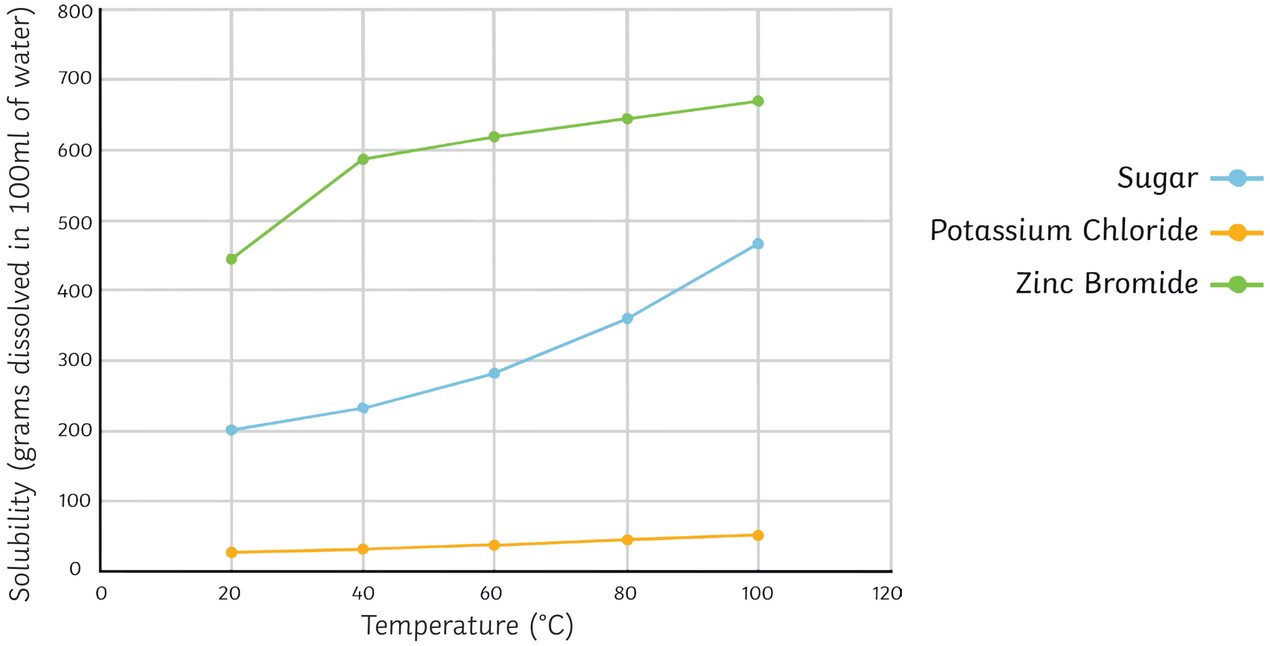
c. Victor adds sodium chloride (salt) to water to make brine.

The water is the... ______________________________

The sodium chloride is the... ______________________________

The brine is a... ______________________________

3. Parminder added three different solutes to different temperatures of water. She recorded how many grams could be added until the solution became fully saturated and then plotted this on the graph below.



a. Which substance has the highest solubility at 100°C?

b. Which substance has the lowest solubility at 50°C?

c. Why do you think Parminder did not choose to use sand or chalk for this experiment?

d. Describe the curve for zinc bromide. **Tip**: When you describe a pattern on a graph in science, try to structure your sentence to include a verb, adverb and two pieces of data.

Learning Objectives:

- ☐ I can identify keywords.
- ☐ I can apply keywords to new situations.
- ☐ I can extract information from a graph.
- ☐ I can describe patterns on graphs.

Solubility Quick Assessment **Answers**

1.

a. The liquid a substance is being dissolved in. **solvent**

b. The solid substance being dissolved. **solute**

c. A substance that will not dissolve. **insoluble**

d. A mixture of a solute and solvent that will not separate out. **solution**

e. A substance that will dissolve. **soluble**

f. A solution that won't dissolve anymore solute at that temperature. **saturated**

g. A measure of how much solute will dissolve. **solubility**

2.

a. The gravy granules are the... **solute**

The water is the... **solvent**

The gravy is a... **solution**

b. The potassium permanganate is the... **solute**

The water is the... **solvent**

The purple mixture afterwards is a... **solution**

c. The water is the... **solvent**

The sodium chloride is the... **solute**

The brine is a... **solution**

3.

a. Which substance has the highest solubility at 100°C? **zinc bromide**

b. Which substance has the lowest solubility at 50°C? **potassium chloride**

c. Parminder did not choose to use sand or chalk for this experiment as they are **insoluble**.

d. Describe the curve for zinc bromide: The solubility of zinc bromide is 447g in 100ml of water at 20°C and rises sharply to 591g at 40°C, then continues to rise but more gradually to 672g at 100°C.

The key teaching point here is to prepare students for GCSE style questions and to start using verbs and adverbs, alongside data points.

Solubility Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can identify **some** keywords from their definitions.	You can identify **most** keywords from their definitions.	You can identify **all** keywords from their definitions.
With guidance, you can apply **some** keywords to new situations.	You can independently apply **most** keywords correctly to new situations.	You can independently apply **all** keywords correctly to new situations.
With guidance, you can **identify** substances with high and low solubility.	You can independently **identify** substances with high and low solubility.	You can independently **identify** substances with high and low solubility and **suggest** why some substances were not used.
With guidance you can find at least one piece of data on a graph.	You can independently find at least one piece of data from a graph.	You can independently find data on a graph and use units in your answer.
With guidance you can use basic verbs to describe the pattern of the graph.	You can independently use verbs to describe the pattern of a graph.	You can independently use verbs and adverbs to describe the pattern of a graph.

Next Steps:

Solubility
Teaching Ideas

Learning Objective:	To plan an investigation on solubility.
Success Criteria:	• To define keywords. • To apply keywords to situations. • To design a safe and valid experiment. • To describe how temperature affects solubility.
Context:	This is the sixth lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Starter

A Nice Cup of Tea

On slide 3 is a picture of a cup of tea alongside a question asking, 'When you add sugar to a cup of tea what happens to the sugar, mass of the tea and, if the tea is made with cold water?' This allows students to draw upon their knowledge of an everyday situation regarding solutions, and for the teacher to gauge the students' understanding of solubility.

Main Activities

Adding Sugar to Water

Slides 4-6: Discuss and explain the science behind the starter activity. On slide 4 a common misconception is addressed, that dissolving is not disappearing and in fact the mass of the two substances are added together. On slide 5, students are asked: when making tea with colder water, why would the sugar take longer to dissolve, if it all? Slide 6 explains the basic science behind this: that the kinetic energy of the water particles is higher in hotter water, and their collisions with the sugar molecules cause the bonds in the sugar cube to be broken. This is a simplified explanation for key stage 3 students.

Keywords Activity

Slides 7-9: Students are introduced to three keywords 'solute', 'solvent' and 'solution' and their definitions are given on slide 7. On this slide, students are asked to draw a cup of tea in their books and annotate the correct definition next to each part of the tea. Answers are shown on slide 8. On slide 9, the additional keywords 'saturated' and 'insoluble' are introduced, and students should copy these down for use in the next task.

Planning an Experiment Activity Sheet

Slides 10-11: Students follow one of the differentiated activity sheets to plan a safe and valid experiment into dissolving sugar in water at different temperatures. Both activity sheets follow the same six steps of: writing a paragraph containing background information and keywords; writing a method; drawing how the particles look before and after adding the sugar; designing a risk assessment; identifying variables, and creating a prediction. Students should be encouraged to check their plans with their peers, and to complete the peer assessment sheet included, and respond to feedback. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given. If time, resources and your school permit, students can also perform this experiment during the lesson.

Solubility Quick Assessment Sheet

Slide 12: Students follow the activity sheet to demonstrate their knowledge of solubility by answering exam style questions. The final question shows a solubility curve designed to test students on their graph analysis and description skills. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Slides 13-15: Show students the three pictures on slide 13 of a beach, making coffee and bath bombs with the question, 'How many keywords can you spot in these pictures?' Students could write their answers for each on mini whiteboards, in their books, or work in pairs to make a list. Answers are given on slide 14.

Remind the students of today's success criteria on slide 15 of the PowerPoint.

Suggested Home Learning

Students could write a list of the solutions they make over the next week and apply today's keywords to each situation.

Filtration Invention Peer Assessment Grid

Names of people in group:	How much science content was in the presentation? /5	How innovative was the group? /5	How clear was the presentation? /5	Did everyone in the group take part? +2 or -2	Total Score: /17 maximum

Filtration Invention!

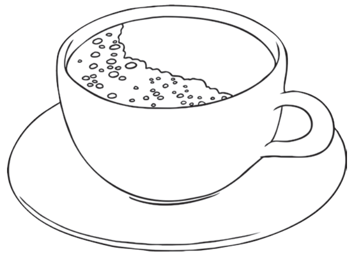
Aim: To design a water filter invention and present it as a sales pitch.

Criteria:

Must: Include at least two cheap filtering materials.

Should: Explain how your design works using scientific keywords.

Could: Use persuasive language and statistics.



Suggested sequence of your 'pitch' (presentation):

Hi, we are... (state the company name, individual names and brief introduction of each of your roles)

We'd like to talk to you today about our new invention, which is... (Use the reverse of this sheet to sketch your initial ideas)

We think there is a need for this product because...

We would like your help and financial support because...

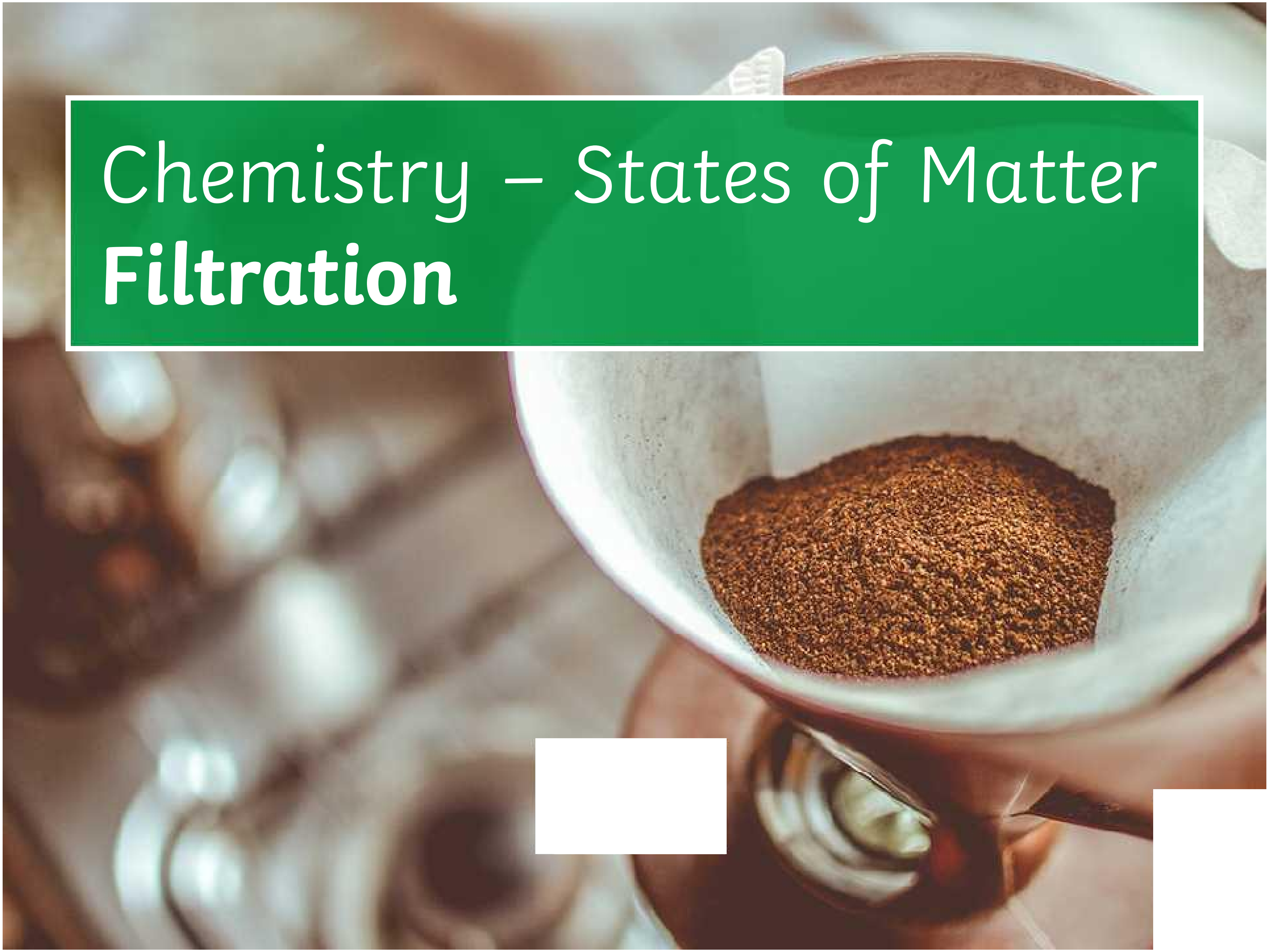
Use this space to sketch your initial ideas after discussing them as a group:

Think about:

- The types of materials to use for the filter.
- The relative cost of the materials (no exact figures needed).
- Whether your design is for individual families to use or for whole communities.

Final Design:

Chemistry – States of Matter
Filtration



Learning Objective

- To understand how filtration works and its everyday importance.

Success Criteria

- To define keywords relating to filtration.
- To apply keywords to real-life situations.
- To design a filter and communicate ideas clearly.

Starter

What do all of these have in common?

Filtration

They all rely on **filtration**!

Filtration, or filtering, is a **separation technique**.

You will learn other separation techniques over the next few lessons, including:

- Evaporation
- Distillation
- Chromatography

Filtering in Animals

Flamingos are part of a subgroup of animals called **filter feeders**.

They feed by sieving food from water, using specialised structures.

Baleen whales, oysters and some species of sharks, fish and ducks are part of this group too!

Everyday Filtering

There are filters in cars, vacuums and tumble dryers too.

What do you think they might be made of?

What do you think they might be filtering out?

Filtering

Cars have air and oil filters. They help to filter out any impurities.

Vacuums have filters to trap the dust.

Tumble dryers have filters to capture threads and hair.

Keywords

The material being used is called the **filter**.

The substance that can move through the filter is called the **filtrate**.

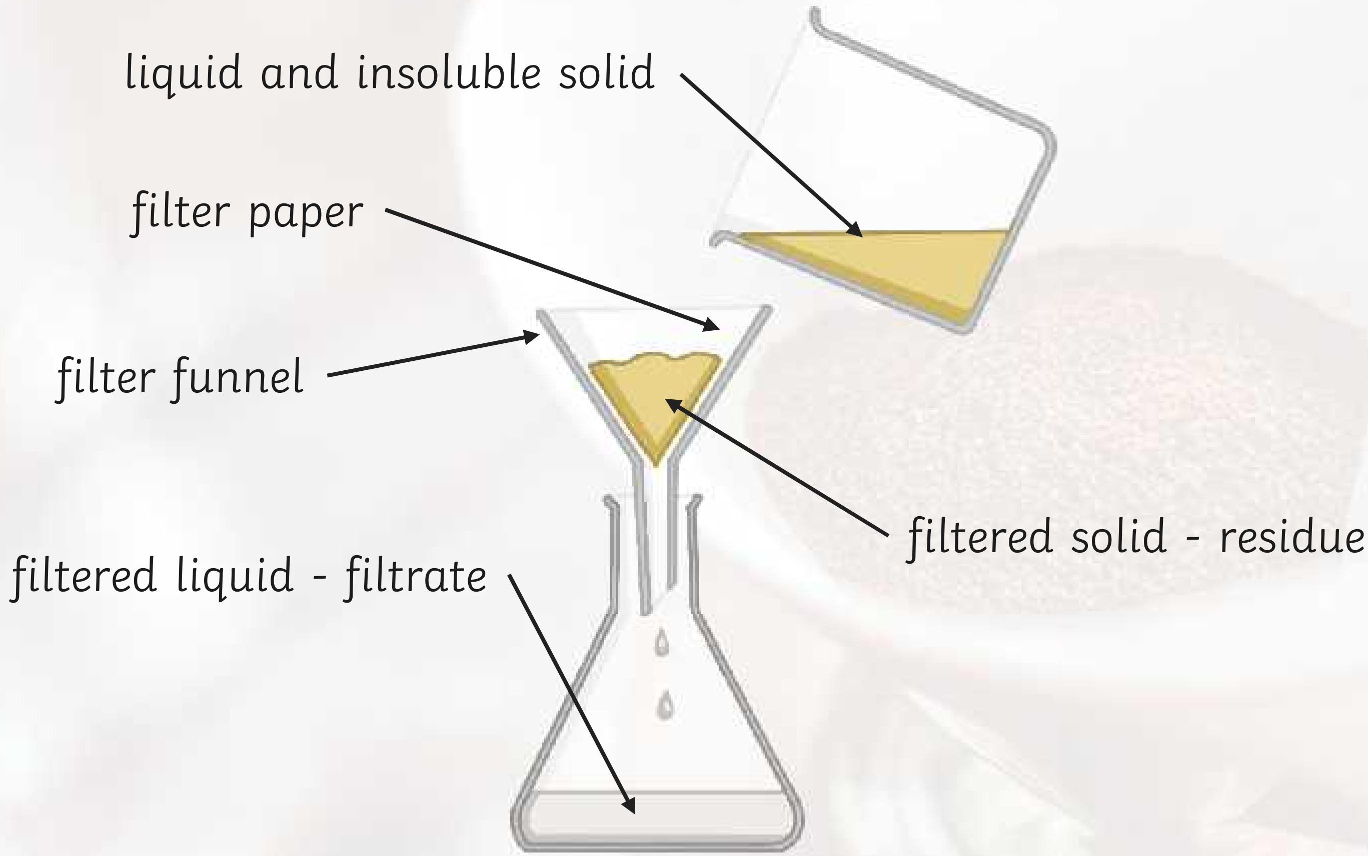
The substance that is left behind in the filter is called the **residue**.

The process is called **filtration**.

Challenge:
Can you draw and label the apparatus with these keywords?

Answers

Title of Diagram: Filtration



Filtration Invention!

Statistics from WaterAid:

- **844 million** people in the world do not have clean water.
- At current rates of progress, everyone in low- and middle-income countries won't have clean water until 2039.
- Around 289 000 children under five die every year from diseases caused by poor water and sanitation. That's almost 800 children per day, or **one child every two minutes**.

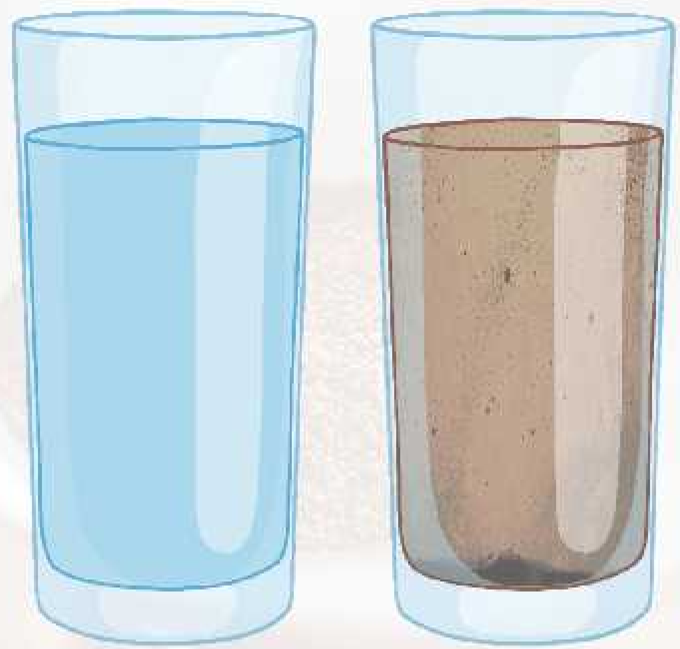
Filtration Invention!

Water from lakes and rivers is often **contaminated** and so is **not safe** for drinking.

The water may contain grass, dirt, rocks and other objects that can be easily seen.

However, it often also contains **bacteria** and other **microscopic organisms** that cannot be seen easily.

Your aim is to design an **affordable** way of filtering water.



Filtration Invention!

Aim: to **design** a water filter and **present** it as a sales pitch!

Criteria:

Must: Include at least two cheap filtering materials.

Should: Explain how your design works using scientific keywords.

Could: Use persuasive language and statistics.

Activity Sheet

Follow the **Filtration Invention! Activity Sheet** to plan your presentation.

Quick Assessment Sheet

Complete the **Quick Assessment** sheet to show your understanding of today's lesson.

Plenary

Think of six words from today's lesson.

Write them in order of importance to you in a diamond shape.

Explain your reasons why you placed certain words at the top and bottom.

Compare with a peer.

Most important word

Highly important word | Highly important word

Less important word | Less important word

Least important word

Example

Filter

Filtrate Residue

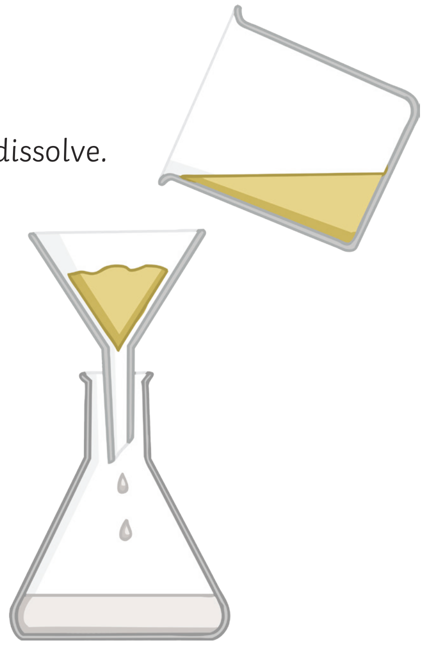
Insoluble Bacteria

Soluble

What Did You Achieve Today?

- I can define keywords relating to filtration.
- I can apply keywords to real-life situations.
- I can design a filter and communicate my ideas clearly.

Filtration **Quick Assessment**



1. Read the paragraph below:

When sand and water are mixed together in a beaker, the sand does not dissolve. To separate the sand out from the water, you must pour the mixture through a piece of filter paper, folded into a funnel and with a conical flask placed underneath. The sand should remain trapped in the filter paper and the water in the conical flask should now be clear.

a. The sand and water together in the beaker is called a ______________.

b. The sand is the _______________ because ____________________________

____.

c. The paper is the ______________ because _________________________

____.

d. The liquid at the end of the experiment is called the ___________________

because ____________________________________.

e. Sand does not dissolve in water, so we call it __________________________.

2. Explain why sand can be separated from water using this technique.

____

____

____

3. Sadiq carries out the experiment as described in question 1. However, his water still has sand in it.

a. Suggest what Sadiq might have done wrong.

____

____

b. How could you improve Sadiq's experiment to ensure clear water?

____

____

4. Marissa carries out the experiment as described in question 1, but uses salt instead of sand. Describe what the particles would look like in the end filtrate.

Success Criteria:

- ☐ I can apply and define keywords.
- ☐ I can explain how filtering works.
- ☐ I can suggest reasons for errors in experiments.
- ☐ I can suggest improvements in experiments.
- ☐ I can link filtration to solubility.

Filtration Quick Assessment **Answers**

1.

a. The sand and water together in the beaker is called a **mixture**.

b. The sand is the **residue** because **it is left behind in the filter paper**.

c. The paper is the **filter** because **it is the material the filtrate passes through**.

d. The liquid at the end of the experiment is called the **filtrate** because **it has passed through the filter**.

e. Sand does not dissolve in water, so we call it **insoluble**.

2. Explain why sand can be separated from water using this technique.

Student responses could be:

- **The water goes through the filter and becomes the filtrate, but the sand cannot because it is too big, so it is left behind as the residue.**
- **The holes in the filter paper let the water through, but the sand is too big.**
- **Only the water can go through the filter, the sand stays in the filter.**

3. Sadiq carries out the experiment as described in question 1. However, his water still has sand in it.

a. Suggest what Sadiq might have done wrong.

He used a filter material with gaps larger than the grains of sand.

b. How could you improve Sadiq's experiment to ensure clear water?

He should use a finer filter material, with gaps smaller than the grains of sand.

4. Marissa carries out the experiment as described in question 1, but uses salt instead of sand. Describe what the particles would look like in the end filtrate.

Salt is soluble in water, so it will dissolve and move through the filter paper with the water particles, into the end filtrate. The particles in the filtrate would therefore be composed of both salt and water.

Filtration Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can identify **some** keywords.	You can identify **most** keywords and recall their definitions.	You can identify **all** keywords and recall their definitions.
With guidance, you can **describe** simply how filtering works.	You can independently **describe** how filtering works.	You can independently **describe** how filtering works using keywords.
With guidance, you can **suggest** a simple idea for an error in an experiment.	You can independently **suggest** a general reason for an error in an experiment.	You can independently **suggest** a scientifically valid reason for an error in an experiment.
With guidance, you can **state** a simple idea for an improvement in an experiment.	You can independently **state** a general idea for an improvement in an experiment.	You can independently **state** a scientifically valid idea for an improvement in an experiment.
With guidance you can **recall** that salt is soluble in water.	You can independently **recall** that salt is soluble in water.	You can independently **recall** that salt is soluble in water and **link** filtering and solubility.

Next Steps:

Filtration
Teaching Ideas

Learning Objective:	To understand how filtration works and its everyday importance.
Success Criteria:	• To define keywords relating to filtration. • To apply keywords to real-life situations. • To design a filter and communicate ideas clearly.
Context:	This is the seventh lesson of the topic of 'States of Matter' in key stage 3 Chemistry.

Starter

As students enter the classroom and settle, on slide 3 are five pictures of flamingos, a car, a coffee maker, a designer teapot and a water filter alongside a question asking 'What do all of these have in common?' This allows students to draw upon their knowledge of an everyday situation regarding filtering and for the teacher to identify and address any misconceptions.

Main Activities

Filtering Introduction

Slides 4-6: Discuss and explain the science behind the starter activity. On slide 4, the idea of filtering being one of many separation techniques is introduced. On slide 5, an explanation of filtering in animals and examples of filter feeders are given to engage students and encourage them make links to Biology. On slide 6, the idea of filters being in everyday objects such as cars, vacuums and tumble dryers is stated. Students are prompted to consider the materials these filters might be made out of and what they might be filtering. On slide 7 are the simplified answers to the substances being filtered, but no answers are intentionally given about the materials as these ideas will be useful for the activity later on.

Keywords

Slide 8: Students are introduced to the four keywords, 'filter, 'filtrate', 'residue' and 'filtration', and their definitions are also given. Students should be encouraged to note these down to use in the next activity. An extension activity is given to draw the filtering apparatus and apply the keywords to the diagram. Answers are given on slide 9 with more detail given to encourage the correct naming of scientific apparatus.

Filtration Invention Activity Sheet

Slides 10-13: The aim of the activity is for students to work in small groups to design a water filter and prepare a sales 'pitch' to present to the class. The background information of the activity is presented to the class with some statistics from WaterAid on slide 10 and further information on unsafe drinking water on slide 11. The aim and success criteria are given on slide 12 and students should work in small groups to follow the activity worksheet. If time permits during the lesson, all pitches could be presented to the class, with the teacher acting as the 'investor'. There is also a **Peer Assessment Grid** for students to complete upon watching their classmates' presentations. Afterwards, students could vote for their favourite pitch, using 'heads down, thumbs up' and a prize could be awarded to groups with the top 3 pitches.

Filtration Quick Assessment Sheet

Slide 14: Students follow the worksheet to demonstrate their knowledge of filtration by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Slides 15–16: Ask students to think of six keywords from today's lesson and write them in order of importance as shown on the diagram, similar to a 'diamond nine' activity. More able students should be encouraged to annotate why they placed certain words at the top and bottom of the diamond. An example answer is given on slide 16. Remind the students of today's success criteria on slide 17 of the PowerPoint.

Suggested Home Learning

Students could produce a research poster on one or more 'filter feeders' containing a picture, scientific keywords from today's lesson and fascinating facts.

States of Matter
Evaporation

Learning Objective

- To understand how to use evaporation as a separation technique.

Success Criteria

- To identify scientific apparatus.
- To safely follow a method.
- To apply keywords to a practical.

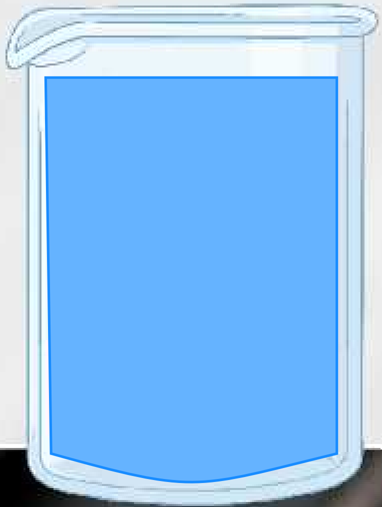
Starter: Word Jumble

How many words can you spell from today's key word?

EVAPORATION

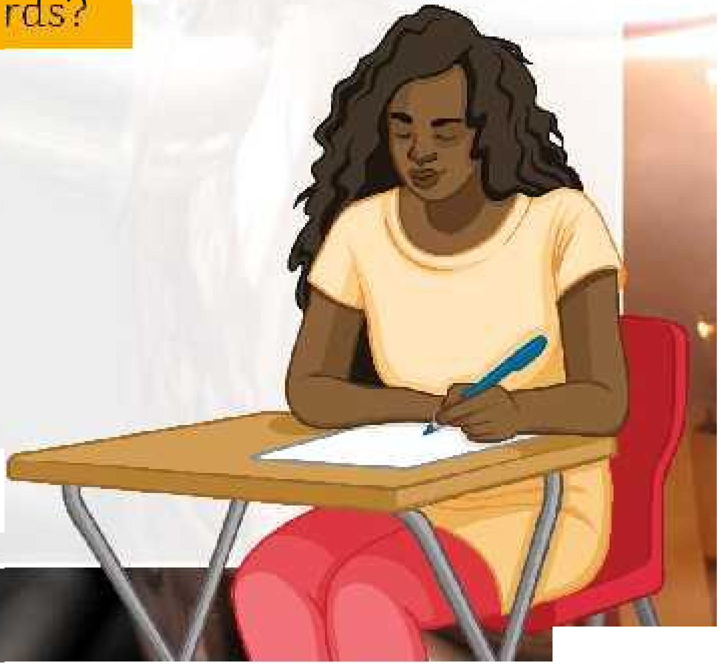
Challenge 1: Can you make only words of four letters or more?

Challenge 2: Can you create any scientific keywords?



You have three minutes until all the water evaporates!

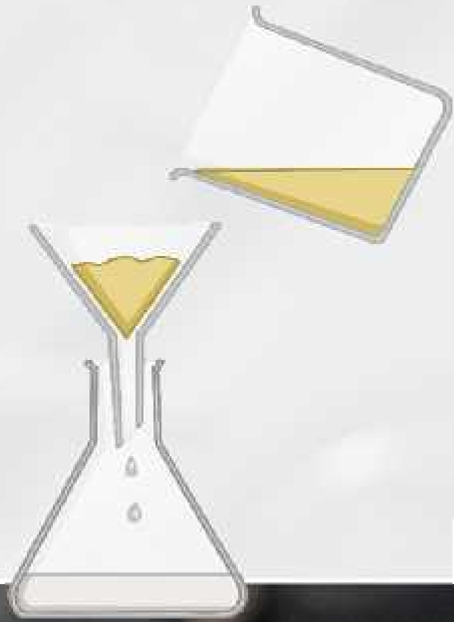
Begin!



Recap

A mixture contains **two** or more substances that are not **chemically** joined together (**bonded**).

You can (usually) easily **separate** them using **physical** methods.



So far we have looked at one **separation technique** called filtering.

Separation Techniques

Today you will learn a new separation technique using **evaporation**.

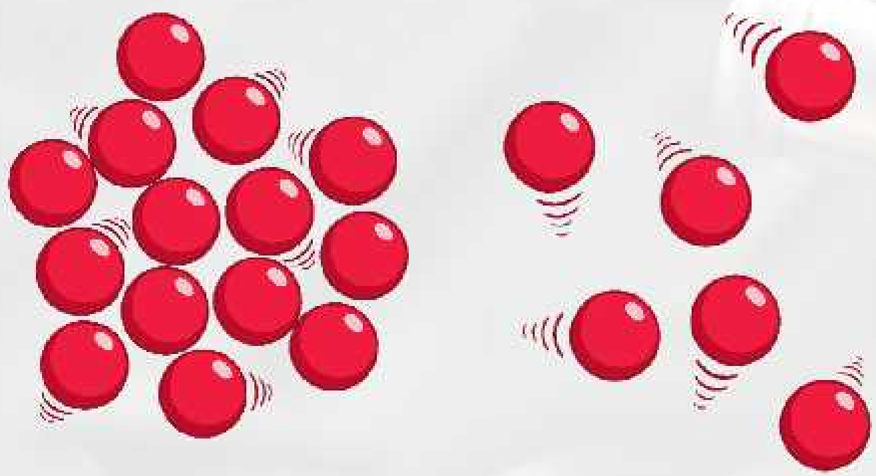
You will **also** use your **filtering** and **solubility** knowledge.

Your skills will also be tested on **identifying** and **labelling apparatus**!

Evaporation

Evaporation is the change of state from a **liquid** to a **gas**.

Remember this takes **energy** to **overcome** the **force** of attraction **between** the **particles**!



Background Information

This is **halite**.

It is more commonly known as rock salt.

It is an impure substance.

Rock salt is a mineral made from sodium chloride.

Pause for Thought
Sodium chloride has the formula NaCl. How many elements are present?

There are **two** elements. Always focus on the capital letters!
Na = Sodium
Cl = Chlorine

Background Information

The colours in rock salt are from impurities such as sand.

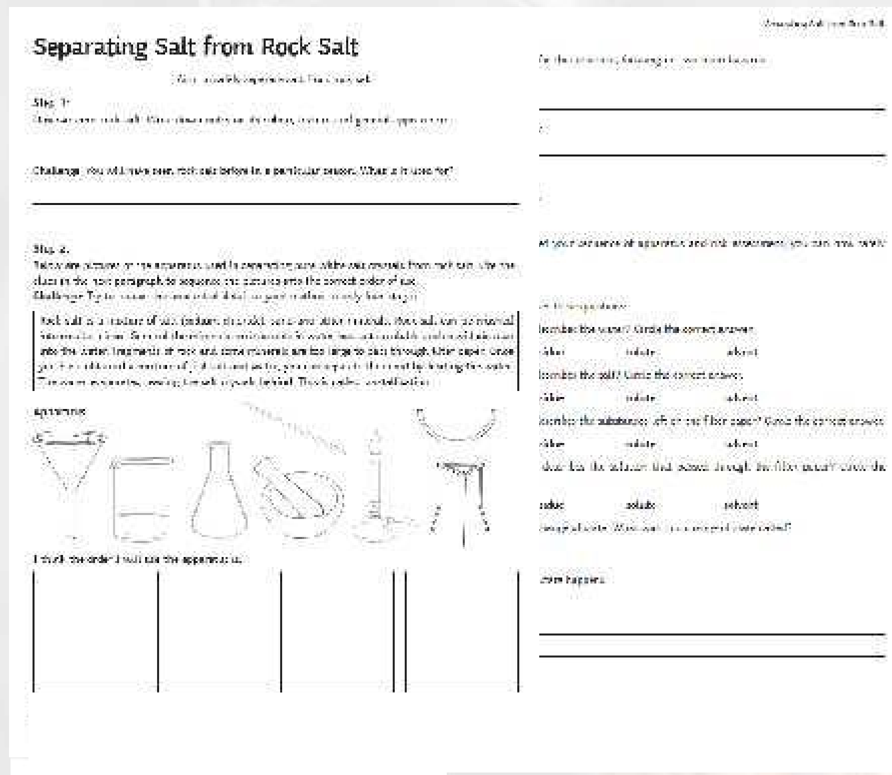
There are large deposits of rock salt underground in various places across the UK.

They were formed by the **evaporation** of water.

Activity Sheet

Your aim is to safely separate pure salt from rock salt.

Follow the **Separating Salt from Rock Salt** sheet to safely plan and complete the practical.



Separating Salt from Rock Salt

Step 1:

Step 2:

Apparatus

Salt Lakes

A salt lake is an inland body of water.

It is formed when water with a high concentration of salts flows in.

There are some organisms that like living in high salt concentrations called ‘halophiles’. This comes from the Greek word for ‘salt loving’.

Salt Lakes

Brine shrimp are an example of a halophile.

They are found in the Great Salt Lake, United States.

They only grow to 1cm but are the largest organism to survive the extreme salinity of the water!

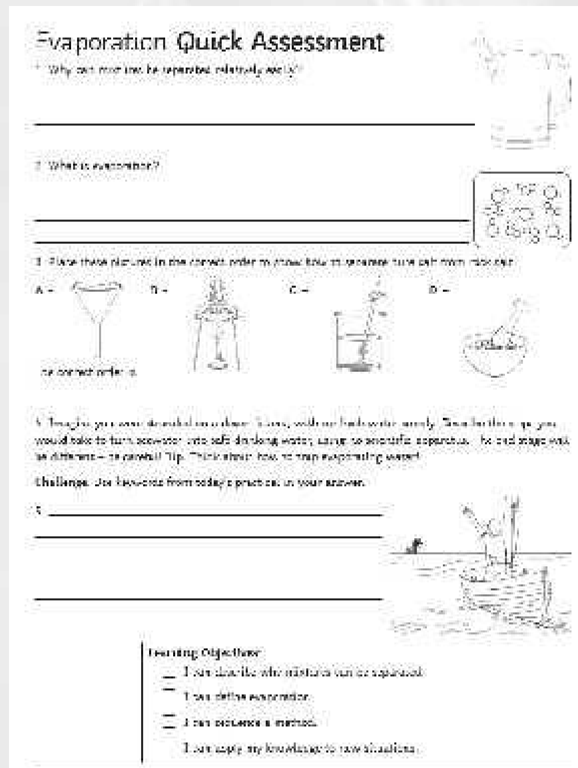
Salt Lakes

Salt flats can form when the water evaporates and leaves the salt behind.

Pause for Thought
What causes this evaporation to happen?

Quick Assessment Sheet

Now complete the **Evaporation Quick Assessment** sheet to show your understanding of today's lesson.



Plenary: Copper Sulfate

These are copper sulfate crystals.

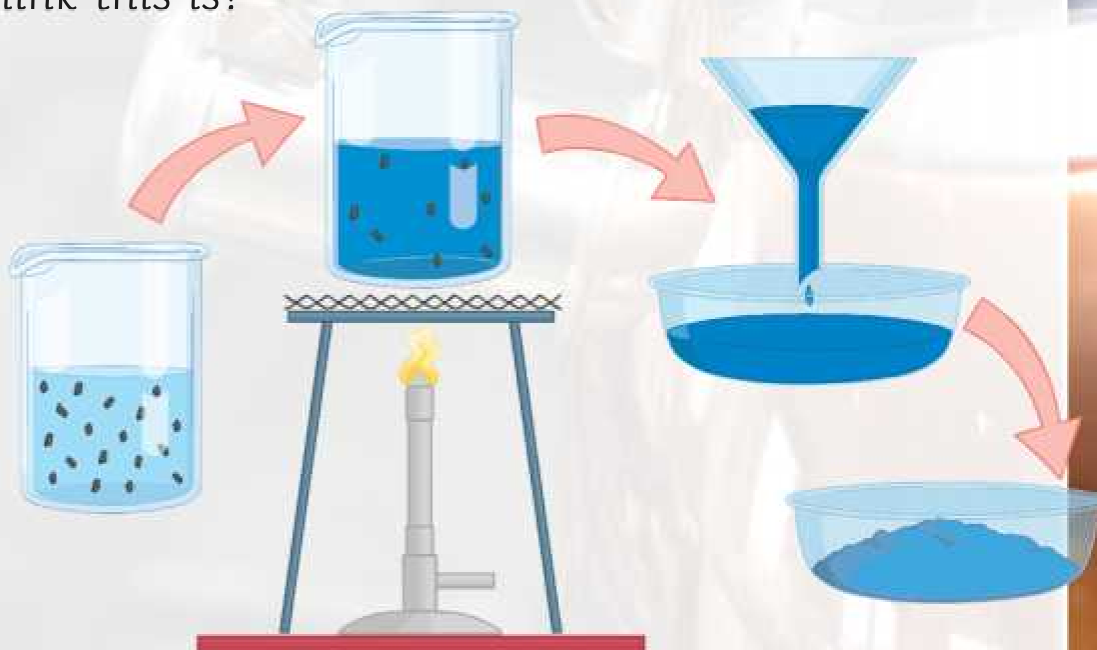
Plenary: Copper Sulfate

Here is the method for making copper sulfate crystals. Discuss the following questions in pairs:

1. How is the method for making these **similar** to your rock salt practical?

2. How is the method for making these **different** to your rock salt practical?

3. Challenge: Why do you think this is?

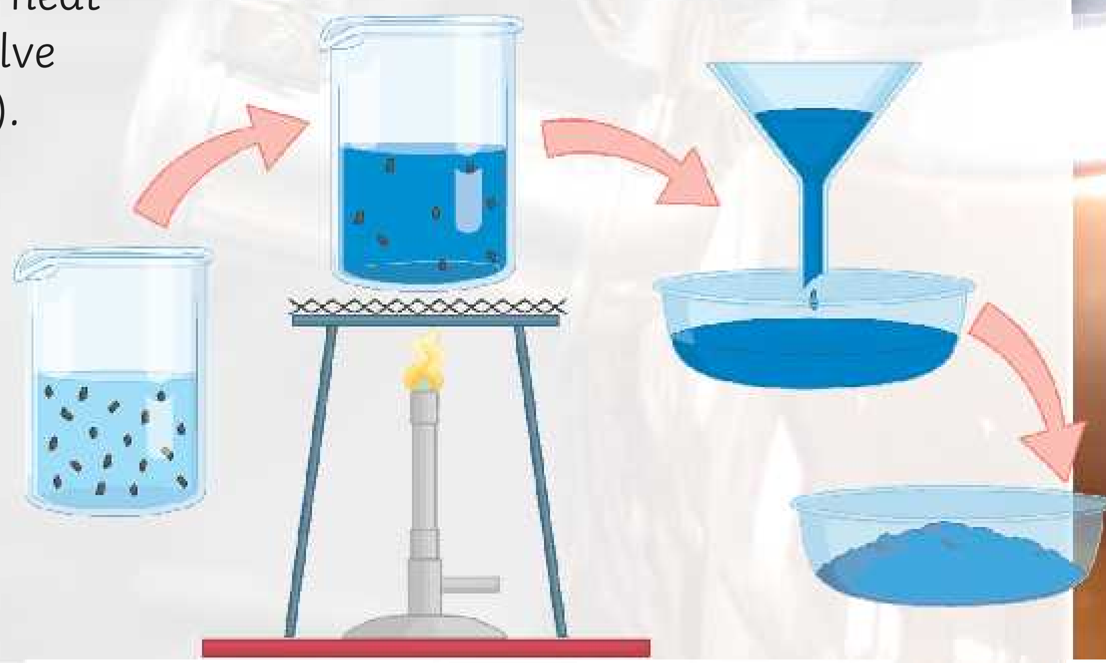


Answers: Copper Sulfate

1. Steps 1, 3 and 4 **look similar** to your rock salt practical.

2. Step 2 is **different** to your rock salt practical. There is also no step to grind the copper sulfate using a pestle and mortar.

3. Copper oxide (the black dots) is actually **insoluble** and so heat energy is needed for it dissolve in the **solvent** (sulfuric acid).



What Did You Achieve Today?

- I can identify scientific apparatus.
- I can safely follow a method.
- I can apply keywords to a practical.

Evaporation **Quick Assessment**

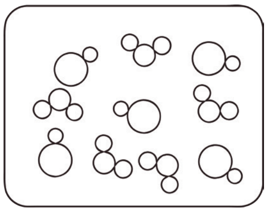
1. Why can mixtures be separated relatively easily?

____

____

____

2. What is evaporation?



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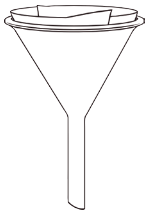
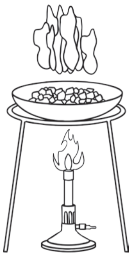
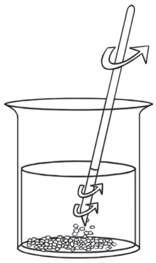
3. Place these pictures in the correct order to show how to separate pure salt from rock salt.

A = 

B = 

C = 

D = 

The correct order is:

_____ _____ _____ _____

4. Imagine you were stranded on a desert island, with no fresh water supply. Describe the steps you would take to turn seawater into safe drinking water, using no scientific apparatus. The end stage will be different – be careful! **Tip**: Think about how to trap evaporating water!

Challenge: Use keywords from today's practical in your answer.

____

____

____

____

____

____

Learning Objectives:

- ☐ I can describe why mixtures can be separated.
- ☐ I can define evaporation.
- ☐ I can sequence a method.
- ☐ I can apply my knowledge to new situations.

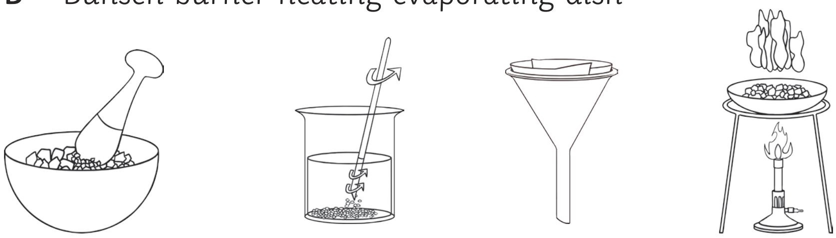
Evaporation Quick Assessment **Answers**

1. Why can mixtures be separated relatively easily?
Mixtures can be easily separated as the **particles** of each **substance** are not **chemically joined** (**bonded**) to each other.

2. What is evaporation?
Evaporation is the **change of state** when a **liquid** becomes a **gas**. In order to achieve this, the **forces** between the **particles** must be **overcome** by supplying heat **energy**.

3. Place these pictures in the correct order to show how to separate pure salt from rock salt.

D = pestle and mortar crushing rock salt, **C** = stirring solution in glass beaker, **A** = funnel and filter paper, **B** = Bunsen burner heating evaporating dish



4. Imagine you were stranded on a desert island, with no fresh water supply. Describe the steps you would take to turn seawater into safe drinking water, using no scientific apparatus. The end stage will be different – be careful! Tip: Think about how to trap evaporating water! Challenge: Use keywords from today's practical in your answer.

Student's answers will vary, but here is a general example:

• obtain seawater;

• find a suitable material/piece of clothing to use as a **filter**;

• place a cup/bucket/container under the filter;

• pour the seawater (a **solution**) though the filter;

• Seaweed/sand etc. will be left behind (the **residue**);

• The **filtrate** will consist of salt and water because **salt** is a **solute** and is **soluble** in water, which is the **solvent**;

• dig a hole and place the filtrate inside;

• build a slightly higher mound of ground next to the hole with the seawater in and add a small container;

• place a piece of material over both holes, secured with stones;

• the water should **evaporate**;

• then be trapped by the material;

• it **condenses** and falls into the small container.

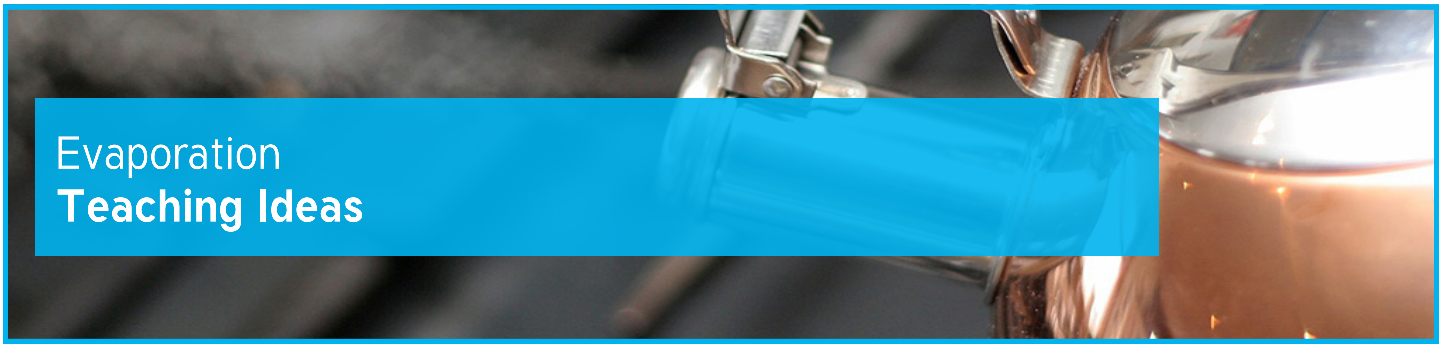
Credit should be given to other method of boiling seawater, trapping the evaporating (pure) water and using a connecting tube to condense it into another container.

Evaporation Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can describe why a mixture can be separated using **some** keywords.	You can describe why a mixture can be separated using **most** keywords.	You can describe why a mixture can be separated using **all** keywords.
You can define evaporation simply, using **some** keywords.	You can define evaporation, using **most** keywords.	You can define evaporation, using **all** keywords and linking the process to energy.
With **guidance**, you can sequence a method.	You can independently sequence a method with **most** steps in the correct order.	You can independently sequence a method with **all** steps in the correct order.
With **guidance**, you can apply **some** of your knowledge to a new situation.	You can **independently** apply **most** of your knowledge and keywords to a new situation.	You can **independently** apply **all** of your knowledge and keywords to a new situation, including the final change of state (condensation).

Next Steps:



Evaporation
Teaching Ideas

Learning Objective:	To understand how to use evaporation as a separation technique.
Success Criteria:	• To identify scientific apparatus. • To safely follow a method. • To apply keywords to a practical.
Context:	This is the eighth lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Resources

Rock Salt Practical – Per group: rock salt, pestle, mortar, 2 x 250ml glass beakers, funnel, filter paper, glass rod, heatproof mat, Bunsen burner, tripod and evaporating basin.

Starter

As students enter the classroom and settle, on slide 3 is a question 'How many words can you spell from today's key word – evaporation?' There are also two extension questions, challenging students to create words of four or more letters, and also to search for scientific words. There is an embedded three minute timer. This starter activity allows for cross curricular links with English and for students to enhance their literacy skills in a competitive manner.

Main Activities

Recap and Separation Techniques

Slides 4-5: On slide 4 is a recap about mixtures including the definition and how they link to separation techniques. On slide 5 is a brief introduction to the lesson, informing students that their prior knowledge of filtering and solubility will be applied in this lesson, alongside general apparatus identification and labelling.

Evaporation

Slide 6: Students are reminded of the definition and conditions of evaporation, with pictorial support of the arrangements of particles in a liquid compared to a gas. Students could note this down, especially if absent for previous lessons, however there is an opportunity to define evaporation in the quick assessment sheet later.

Separating Salt from Rock Salt Activity Sheet

Slides 7-9: The aim of the activity is for students to separate pure salt from rock salt. The background information on rock salt is presented to the class on slides 7 and 8. On slide 7 a question is posed to students based on the chemical formula for sodium chloride 'NaCl', asking students to identify how many elements are in the formula. This allows the teacher to address a common misconception, where students relate the number of letters in a formula to how many elements there are present. The answer swipes in at the end of the slide. On slide 8 a link to rock salt being formed by evaporation is made. Students then follow one of the differentiated worksheets to carry out a safe practical. The lower ability activity sheet has a method provided, with embedded questions to answer on the sheet, to be completed by the student whilst performing the practical. This sheet is also suitable for time limited lessons. The higher ability activity sheet instead asks students to sequence a method based on written clues and diagrams of the apparatus to use. There are questions to answer at the end of the practical, as opposed to during. Both sheets ask students to write a brief risk assessment. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Salt Lakes

Slides 10-12: Show students slides 10-11 to make synoptic links to areas of biology regarding extremophiles, in particular halophile brine shrimps that live in the Great Salt Lake, United States. Show slide 12 to contextualise the lesson and show students how evaporation can occur on large scales in salt lakes and vast salt plains or basins can form. A question is posed to the class, 'What causes this evaporation to happen?' This allows for the teacher to gauge whether students can appreciate that the sun is the source of heat energy in this scenario, different to the Bunsen burner used in the smaller scale practical just performed in class.

Evaporation Mini Assessment Sheet

Slide 13: Students follow the worksheet to demonstrate their knowledge of evaporation by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Slides 14-16: Show students the picture of copper sulfate crystals on slide 14 and if possible have some ready to observe in a sealed petri dish to pass around the class. Show students the pictorial method for making copper sulfate crystals on slide 15. Ask students in pairs to spot the similarities and differences between their rock salt practical in today's lesson and the copper sulfate method. The final question to explain why some steps are different is for higher ability students to explore, no knowledge of making salts from insoluble bases is expected at this Key Stage. Remind the students of today's success criteria on slide 17 of the PowerPoint.

Suggested Home Learning

Students could produce a research poster on 'extremophiles' based on the brine shrimp halophiles found living in the Great Salt Lake, United States. Alternatively, students could complete the **Evaporation Quick Assessment Sheet** if not completed during class time.

Separating Salt from Rock Salt

Aim: to safely separate salt from rock salt.

Step 1:

Observe some rock salt. Write down notes on its colour, texture and general appearance.

____

Challenge: You will have seen rock salt before in a particular season. What is it used for?

____

____

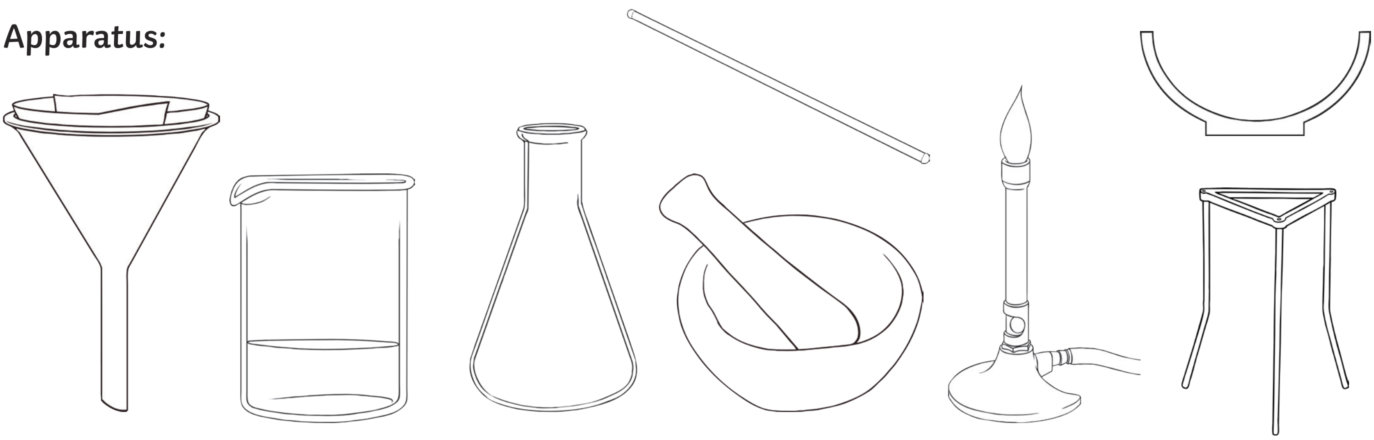
Step 2:

Below are pictures of the apparatus used in separating pure white salt crystals from rock salt. Use the clues in the next paragraph to sequence the pictures into the correct order of use.

Challenge: Try to reduce the amount of detail in your method to only four stages.

Rock salt is a mixture of salt (sodium chloride), sand and other minerals. Rock salt can be crushed into smaller pieces. Some of the minerals are insoluble in water, but salt is soluble and so will dissolve into the water. Fragments of rock and some minerals are too large to pass through filter paper. Once you have obtained a mixture of just salt and water, you can separate them out by heating the water. The water evaporates, leaving the salt crystals behind. This is called crystallisation.

Apparatus:



I think the order I will use the apparatus is:

Step 3:

Write a brief risk assessment for this practical, focusing on two main hazards.

Hazard 1 is ______________________________

It could harm me/others by ______________________________

I will avoid this happening by ______________________________

Hazard 2 is ______________________________

It could harm me/others by ______________________________

I will avoid this happening by ______________________________

Step 4:

Once your teacher has checked your sequence of apparatus and risk assessment, you can now safely carry out the practical.

Step 5:

When it is safe to do so, answer these questions:

a. Which key word correctly describes the water? Circle the correct answer.

filtrate **residue** **solute** **solvent**

b. Which key word correctly describes the salt? Circle the correct answer.

filtrate **residue** **solute** **solvent**

c. Which key word correctly describes the substances left on the filter paper? Circle the correct answer.

filtrate **residue** **solute** **solvent**

d. Which key word correctly describes the solution that passed through the filter paper? Circle the correct answer.

filtrate **residue** **solute** **solvent**

e. The final step relied on a change of state. What was this change of state called?

____

f. Explain how this change of state happens.

____

____

____

Separating Salt from Rock Salt **Answers**

Step 1:

Observe some rock salt. Write down notes on its colour, texture and general appearance.

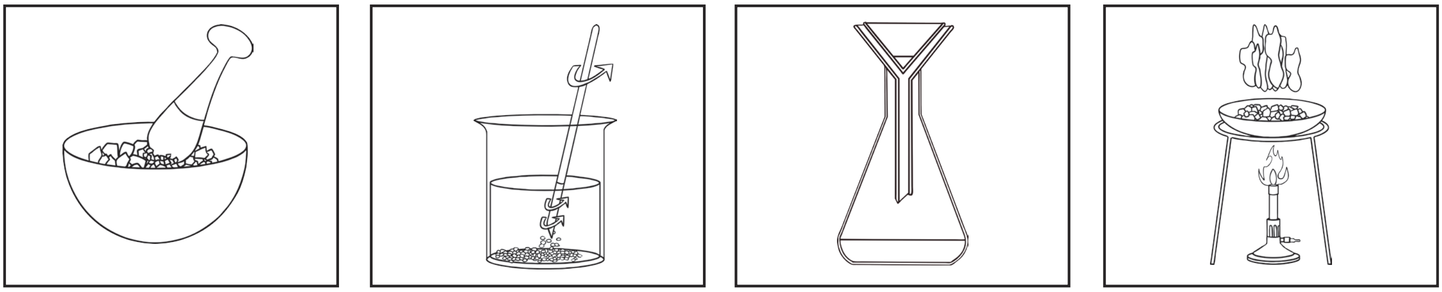
Observations should state the **brown/orange colour** and the appearance of small **crystals**.

Challenge: You will have seen rock salt before in a particular season. What is it used for?

Rock salt is often used to grit roads in winter. It dissolves into the water present and lowers the freezing point of water.

Step 2:

Student answers will vary, but here is a general sequence:



Step 3:

Hazard 1 is the **Bunsen burner.**

It could harm me/others by **burning/scolding skin**.

I will avoid this happening by **remaining focused and informing other students nearby that the Bunsen burner is on. Tying long hair back, wearing goggles and removing trip hazards**.

Hazard 2 is **glassware**.

It could harm me/others by **breaking and piercing skin or going into eyes**.

I will avoid this happening by **wearing goggles and removing trip hazards**.

Step 5:

Which keyword correctly describes the water? **solvent**

Which keyword correctly describes the salt? **solute**

Which keyword correctly describes the substances left on the filter paper? **residue**

Which keyword correctly describes the solution that passed through the filter paper? **filtrate**

The final step relied on a change of state. What was this change of state called? **evaporation**

Explain how this change of state happens. **The water particles gain more kinetic energy when heated, and so move further apart (become less dense). If they gain enough energy to overcome the forces between them, they can move apart and so become a gas.**

Separating Salt from Rock Salt

Aim: to safely separate salt from rock salt.

Step 1:

a. Place some rock salt in the mortar (a thick porcelain bowl).

b. Observe what the rock salt looks like and write a description here:

____

____

c. Gently grind the rock salt into a fine powder using the pestle.

d. Now label the apparatus in the picture to the right.

Words to use:
pestle, mortar, rock salt.

Step 2:

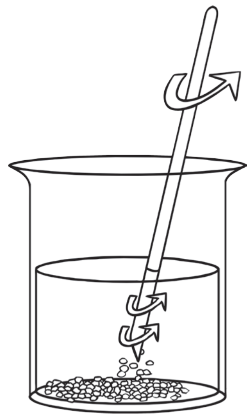
a. Fill a 250ml glass beaker halfway with water.

b. Pour the rock salt powder into the beaker.

c. Stir gently with a glass rod.

d. Complete the word fill:

The salt is the s___________ and the water is the s______________.
When mixed together, they make a s_________________. This only works because salt is s___________ and so will dissolve in water.



Step 3:

a. Collect a conical flask and leave it empty.

b. Collect a funnel and piece of filter paper.

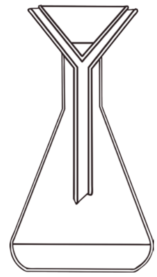
c. Fold the filter paper into quarters and place inside the funnel.

d. Place the funnel (with the filter paper still inside) on top of the conical flask and make sure it is secure to stand alone.

e. Gently pour your solution from step 2 into the funnel.

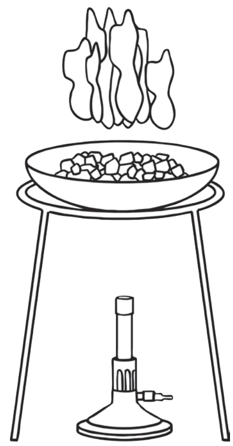
f. Do not touch or poke the solution, it could cause the filter paper to tear!

g. Whilst you wait, label the keywords on the diagram to the right:



Words to use:
filtrate, residue, filter, funnel.

Step 4:



a. Clear a large space near a switched off gas tap and place a heatproof mat on the table.

b. Connect the rubber tubing of the Bunsen burner to the gas tap.

c. Place a metal tripod over the Bunsen burner.

d. Securely place an evaporating basin (a thin porcelain bowl) in the tripod as shown in the picture.

e. Pour a small amount of your filtrate into the evaporating basin.

f. Before lighting your Bunsen burner, write a brief risk assessment:

One hazard is the Bunsen burner, it could...

____

I will avoid this by ______________________________

____

Another hazard is ____________, it could ______________________________

____

I will avoid this by ______________________________

____

Step 5:

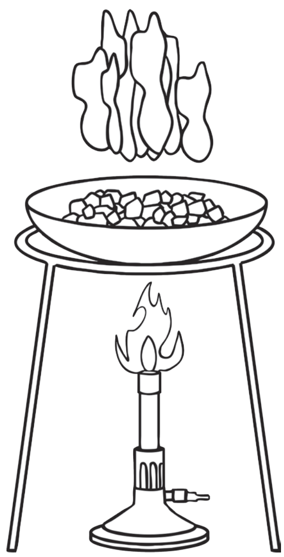
a. Once instructed to do so by your teacher, turn the gas tap on and light your Bunsen burner.

b. Gently heat the filtrate until it starts to boil.

c. What do you notice forming around the edges of the evaporating basin?

____

____



d. Once all of the water has disappeared, turn off the Bunsen burner.

e. Complete the gap fill, once safe to do so:

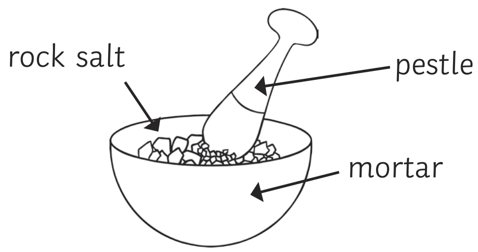
When we heated the f____________, the water (solvent) changed state from a l__________d to a gas and ev__________d, leaving the salt behind. This separation technique of making cr____________ is called crystallisation. Congratulations on successfully separating pure salt crystals from rock salt!

Separating Salt from Rock Salt **Answers**

Step 1:

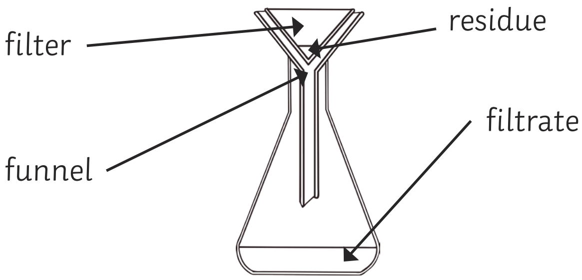
Observations should state the brown/orange colour and the appearance of small crystals.

The apparatus should be labelled as shown:



Step 3:

The apparatus should be labelled with the keywords as shown:



Step 2:

Complete the word fill:

The salt is the **solute** and the water is the **solvent**. When mixed together, they make a **solution**. This only works because salt is **soluble** and so will dissolve in water.

Step 4:

Before lighting your Bunsen burner, write a brief risk assessment:

One hazard is the Bunsen burner, it could **burn/ scold skin**.

I will avoid this by r**emaining focused and informing other students nearby that the Bunsen burner is on. Tying long hair back, wearing goggles and removing trip hazards**.

Another hazard is **glassware**, it could **break and pierce skin or go into eyes**.

I will avoid this by **wearing goggles and removing trip hazards**.

Step 5:

What do you notice forming around the edges of the evaporating basin? **Small white crystals/fine white powder.**

Complete the gap fill:

When we heated the **filtrate**, the water (solvent) changed state from a **liquid** to a gas and **evaporated** leaving the salt behind. This separation technique of making **crystals** is called **crystallisation**.

Separating Salt from Rock Salt Practical **Teacher Feedback**

Effort: 1 2 3 4 5

With **guidance**, you can identify and label scientific apparatus.	You can **independently** identify and label scientific apparatus, spelling most words correctly.	You can **independently** identify and label scientific apparatus, spelling **all** words correctly.
You can identify **some** risks in an experiment and state how they could harm you.	You can identify **most** risks in an experiment, state how they could harm you and state some general prevention methods.	You can identify **all** risks in an experiment, state how they could harm you and state some personalised prevention methods.
With **guidance**, you can follow a given method to perform a practical.	You can **independently** follow a given method to safely perform a practical.	You can **independently** write a method to safely perform a practical.
With **guidance**, you can apply **some** scientific terms to the practical you have performed.	You can **independently** apply **most** scientific terms to the practical you have performed.	You can **independently** apply **all** scientific terms to the practical you have performed.

Next Steps:

Separating Techniques - Distillation

Use this sheet to **think** through what happens in distillation and write your initial ideas down, guided by the questions. Start in the bottom left hand corner and complete the boxes in a clockwise direction.

This piece of science apparatus is a... __________

And it is used for...______________________________

Stage 1: Inside the round bottomed flask is a mixture of ink and water. Describe what is happening to the water particles at this stage.

____

____

____

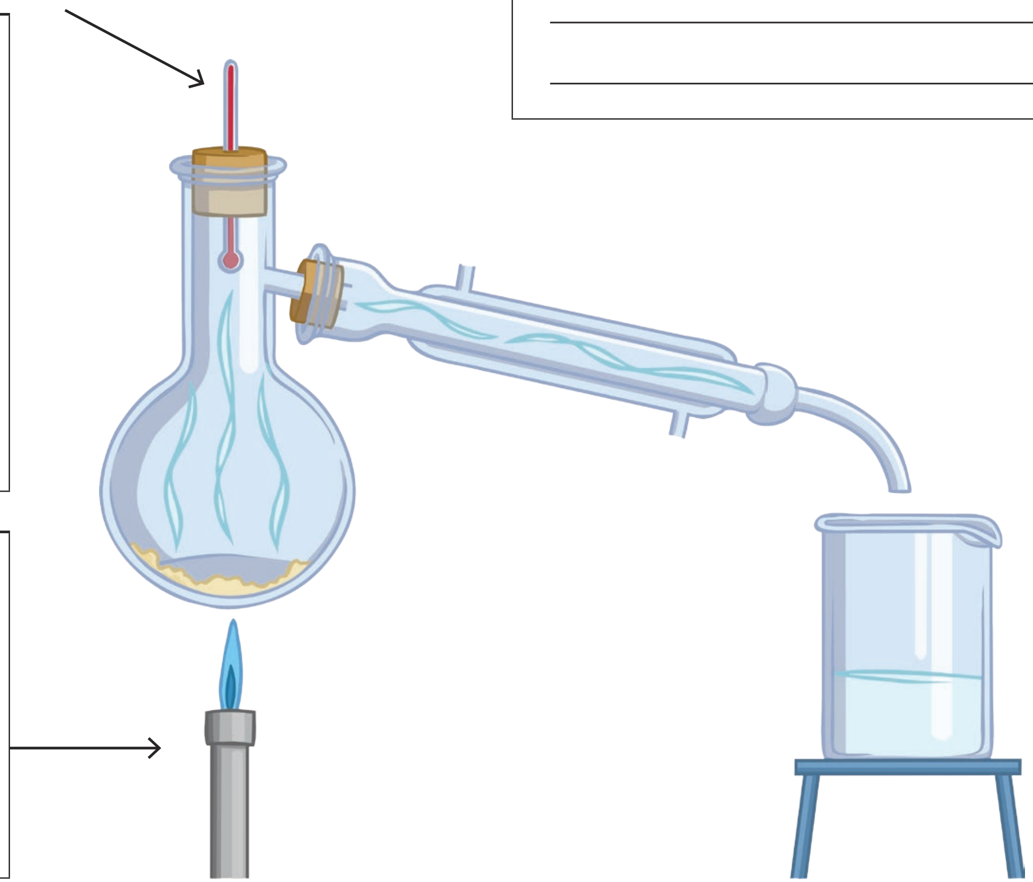
____

Stage 2: Cold water is pumped around this 'tube'. What would happen to the water particles at this stage?

____

____

____



Stage 3: Predict what comes out of the 'tube' into the beaker. Hint: remember this is a separating technique!

____

____

____

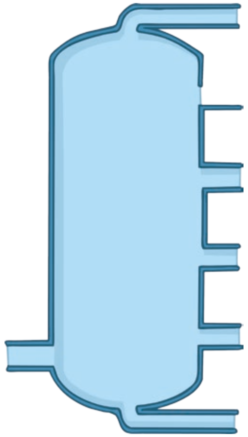
____

Start This piece of science apparatus is a...

____

And it is used for...

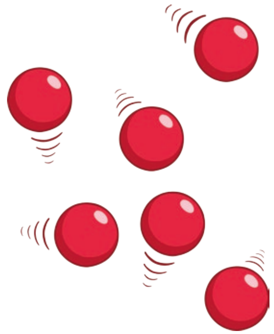
____



Fractional Distillation of Crude Oil

Crude oil is a mixture of useful substances including diesel oil, kerosene (aircraft fuel) and petrol. The crude oil is pumped into a tall column, with several condensers coming off at different heights. The column is approximately 350°C at the bottom and 25°C at the top. Smaller substances with lower boiling points evaporate and move up the column; they lose heat energy and run off into the condensers. Heavier substances with higher boiling points condense and are piped off at the bottom, where it is hotter. The name 'fractional' is because there are several different parts separated out of the mixture.

Fractional Distillation of Air



Air is a mixture of gases including oxygen, carbon dioxide and nitrogen. To separate these out, the air must be cooled down to approximately -200°C where it turns into a liquid. The liquefied air is pumped into a tall column with a condenser at the top. The column is -200°C at the bottom and -190°C at the top. The liquid nitrogen boils and evaporates, changing into a gas and is piped off at the top. Oxygen remains a liquid at the bottom of the column, however it is still mixed with argon as they have a similar boiling point.

Simple Distillation of Seawater

Seawater is a mixture of salt and water, but is unsuitable for drinking due to its high concentration of salt. You can purify water by boiling seawater, cooling the water vapour and condensing it, leaving the salt behind. Middle Eastern countries, such as Saudi Arabia, use this process as they have little rainfall and no permanent rivers. In some places, desalination plants are built next to power plants and they use the waste heat to boil the seawater. This reduces the large cost of heating vast quantities of water.

Chemistry – States of Matter
Distillation

Learning Objective

- To understand how to use distillation as a separation technique.

Success Criteria

- To identify scientific apparatus.
- To explain how distillation works.
- To recognise the everyday uses of distillation.

Starter: Word Association

Describe this picture using as many keywords from this topic.

Start **End**

Your time is up when the bar fades to red.

Answers

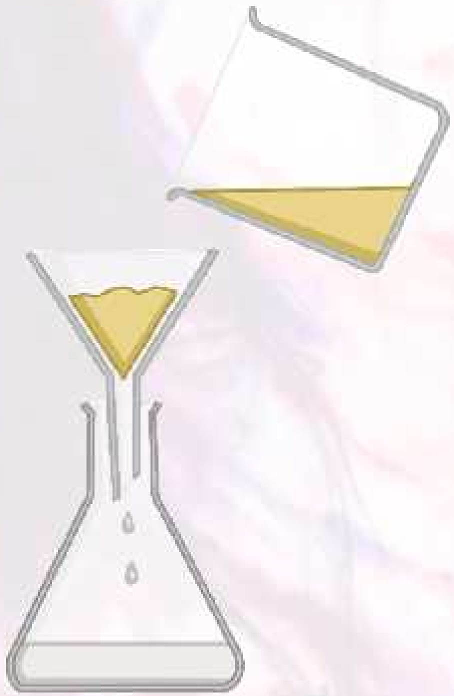
ink = soluble/solute/liquid

water = solvent/liquid

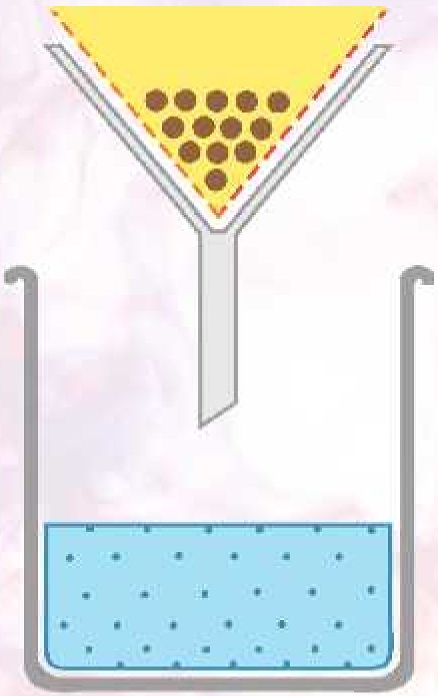
solution/mixture

Recap

So far we have looked at two **separation techniques:**



filtering



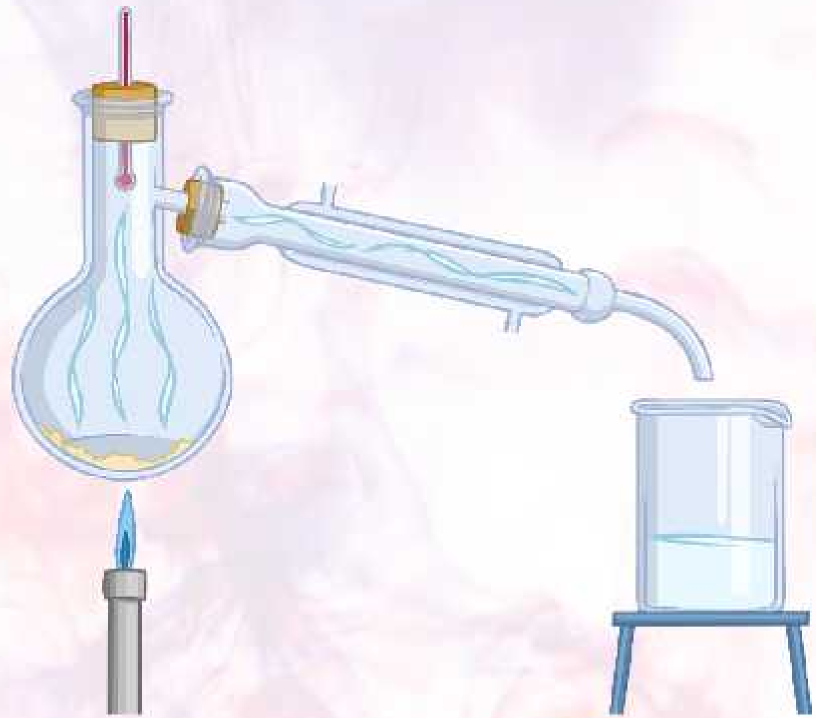
evaporating

Separation Techniques

Today you will learn a new separation technique called **distillation.**

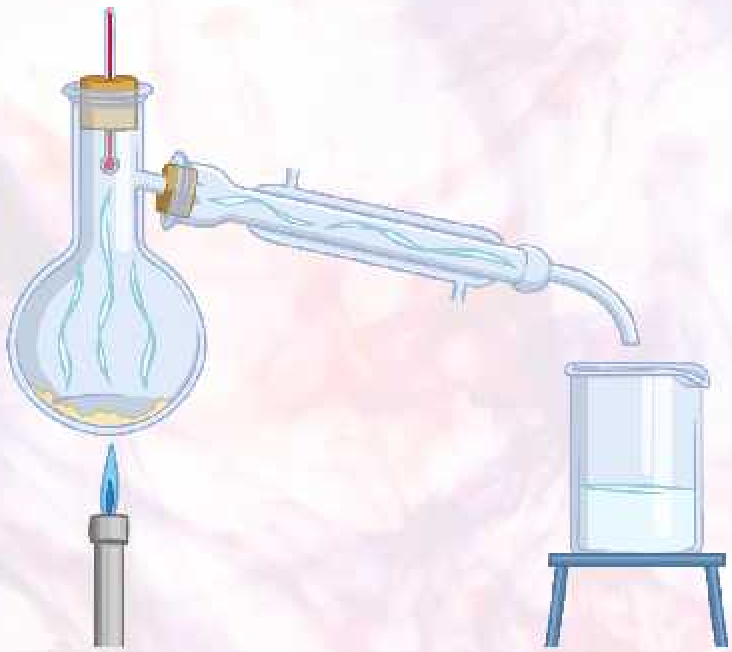
You will **also** use your knowledge of **changing states.**

Your skills will also be tested on **identifying** and **labelling apparatus**!



Distillation Activity Sheet

Use your knowledge of changing states and scientific apparatus to note down your initial ideas on distillation.

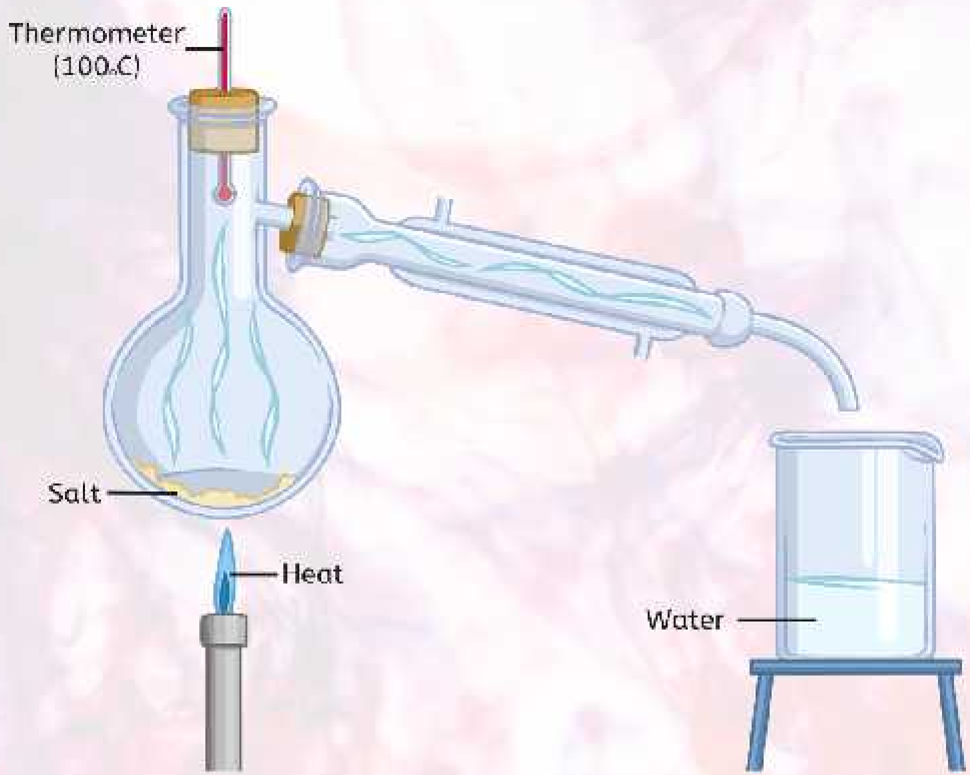


Start **End**

Your time is up when the bar fades to red.

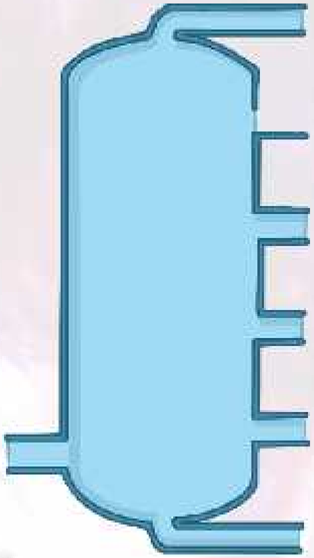
Distillation Demonstration

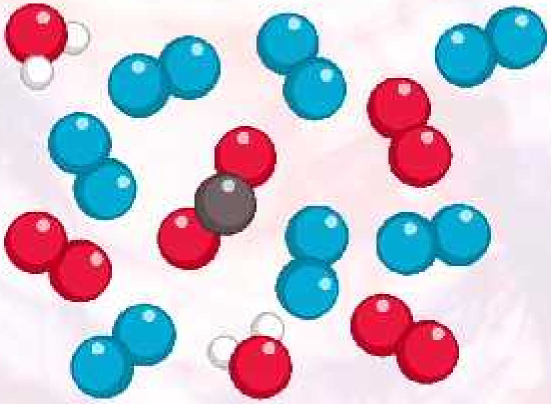
See how close your scientific ideas were as you watch your teacher perform distillation.



Real World Applications

Find the information sheets around the room to make notes on the everyday uses of distillation.





Quick Assessment Sheet

Now complete the assessment sheet to show your understanding of today's lesson.

Plenary

Make two lists in your book:

Apparatus I knew before today	Apparatus I now know from today

Plenary

Make two lists in your book:

Apparatus I knew before today	Apparatus I now know from today
bunsen burner thermometer glass beaker	ound bottom flask condenser

What Did You Achieve Today?

- I can identify scientific apparatus.
- I can explain how distillation works.
- I can recognise the everyday uses of distillation.

Distillation **Quick Assessment**

Nikita has accidentally dropped an open ink cartridge into her water bottle! Kuba thinks he can use some scientific apparatus to separate the ink from the water.

1. Draw and label the apparatus that Kuba will need to set up:

2. Explain how only water will be found in the end container.

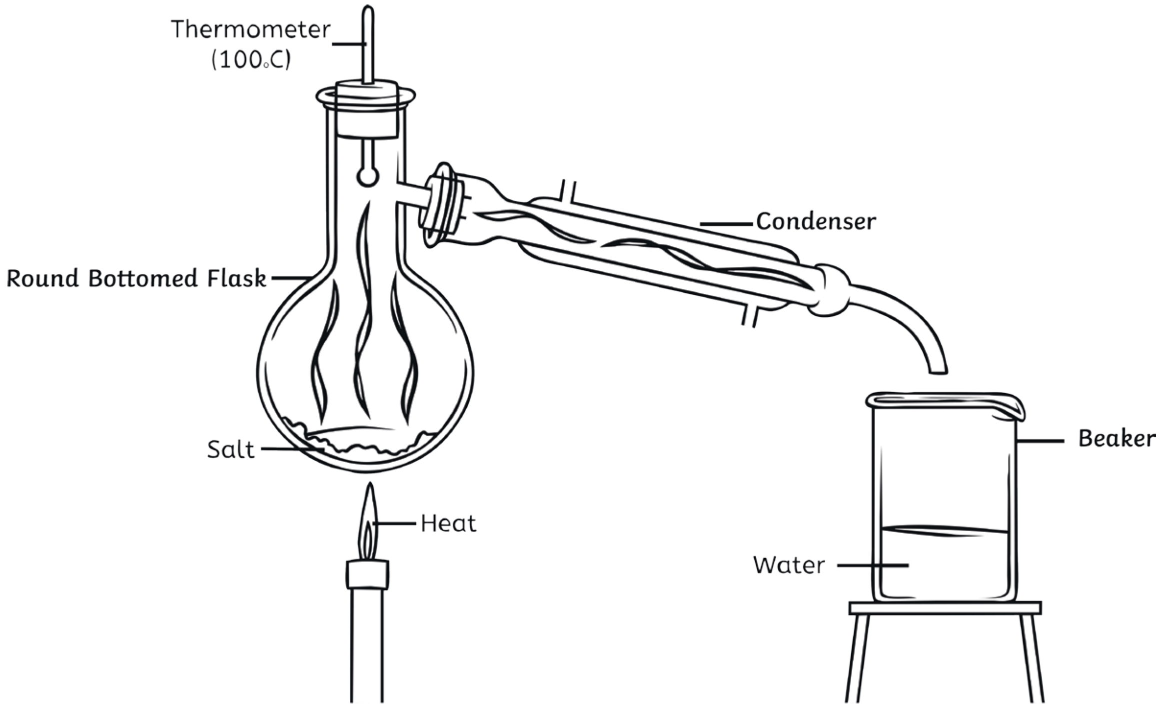
3. How can Kuba check that the water at the end is pure?

Learning Objectives:

- ☐ I can identify and label distillation apparatus.
- ☐ I can explain how distillation works.
- ☐ I can state how to check the purity of water.

Distillation Quick Assessment **Answers**

1.



2. The water particles in the liquid gain enough energy to overcome the forces between them and escape from the surface of the liquid as gas/steam. They evaporate and leave the ink particles behind in the round bottomed flask. The cold water around the condenser makes the water particles lose kinetic energy, and condense down the tube. The beaker then contains pure water in a liquid state.

3. Kuba can check the water is pure by seeing if it boils at 100°C or freezes at 0°C.

Filtration Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can recall some of the apparatus used in the distillation process.	You can recall most of the apparatus used in the distillation process.	You can recall all of the apparatus used in the distillation process.
You can explain distillation simply, using some key words.	You can explain distillation using some key words and link it to some parts of the apparatus.	You can explain distillation using all key words and link the process to key parts of the apparatus.
With guidance, you can state a way of checking the purity of a substance.	You can independently state one way of checking the purity of a substance.	You can independently state two ways of checking the purity of a substance.

Next Steps:

Simple Distillation Sequencing Cards

Place the sentences below in the correct order to show the stages in simple distillation.

Step	Order
The solvent is collected in a beaker.	
The purity of the solvent can be tested by comparing it to known melting and boiling points.	
Place the solution in a round bottomed flask.	
The solvent particles run down the condenser.	
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	
This causes the solvent (for example, water) to evaporate and leave the solution.	
Secure a thermometer in a rubber bung at the top of the flask.	
The solvent particles lose energy and condense into a liquid.	

Simple Distillation Sequencing Cards

Place the sentences below in the correct order to show the stages in simple distillation.

Step	Order
The solvent is collected in a beaker.	
The purity of the solvent can be tested by comparing it to known melting and boiling points.	
Place the solution in a round bottomed flask.	
The solvent particles run down the condenser.	
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	
This causes the solvent (for example, water) to evaporate and leave the solution.	
Secure a thermometer in a rubber bung at the top of the flask.	
The solvent particles lose energy and condense into a liquid.	

Answers

Step	Order
The solvent is collected in a beaker.	7
The purity of the solvent can be tested by comparing it to known melting and boiling points.	8
Place the solution in a round bottomed flask.	1
The solvent particles run down the condenser.	6
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	3
This causes the solvent (for example, water) to evaporate and leave the solution.	4
Secure a thermometer in a rubber bung at the top of the flask.	2
The solvent particles lose energy and condense into a liquid.	5

Simple Distillation Sequencing Cards

Place the sentences below in the correct order to show the stages in simple distillation. The first and last steps have been done for you.

Step	Order
Place the solution in a round bottomed flask.	
The solvent particles run down the condenser.	
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	
This causes the solvent (for example, water) to evaporate and leave the solution.	
The solvent is collected in a beaker.	
The solvent particles lose energy and condense into a liquid.	
Secure a thermometer in a rubber bung at the top of the flask.	
The purity of the solvent can be tested by comparing it to known melting and boiling points.	

Simple Distillation Sequencing Cards

Place the sentences below in the correct order to show the stages in simple distillation. The first and last steps have been done for you.

Step	Order
Place the solution in a round bottomed flask.	
The solvent particles run down the condenser.	
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	
This causes the solvent (for example, water) to evaporate and leave the solution.	
The solvent is collected in a beaker.	
The solvent particles lose energy and condense into a liquid.	
Secure a thermometer in a rubber bung at the top of the flask.	
The purity of the solvent can be tested by comparing it to known melting and boiling points.	

Answers

Step	Order
Place the solution in a round bottomed flask.	1
The solvent particles run down the condenser.	6
Gently heat the bottom of the flask containing the solution with a Bunsen burner.	3
This causes the solvent (for example, water) to evaporate and leave the solution.	4
The solvent is collected in a beaker.	7
The solvent particles lose energy and condense into a liquid.	5
Secure a thermometer in a rubber bung at the top of the flask.	2
The purity of the solvent can be tested by comparing it to known melting and boiling points.	8

Distillation
Teaching Ideas

Learning Objective:	To understand how to use distillation as a separation technique.
Success Criteria:	• To identify scientific apparatus. • To explain how distillation works. • To recognise the everyday uses of distillation.
Context:	This is the ninth lesson of the topic of 'States of Matter' in key stage 3 chemistry.

Starter

As students enter the classroom and settle, on slide 3 is a picture of brightly coloured inks swirling in water alongside a task, 'Describe this picture using as many keywords from this topic as you can.' There is an embedded two-minute timer. This starter activity allows students to reflect and apply their knowledge of the topic so far, and for the teacher to gauge their acquisition of new scientific vocabulary. There are some suggested answers on slide 4.

Main Activities

Recap and Separation Techniques

Slides 5-6: On slide 5 is a recap about the two separation techniques covered in the topic so far. On slide 6 is a brief introduction to the lesson, informing students that their prior knowledge of changing states will be applied in this lesson, alongside general apparatus identification and labelling.

Distillation Apparatus Activity Sheet

Slide 7: Students follow the activity sheet to apply their knowledge of changing states and scientific apparatus to guess what happens in distillation, guided by the questions on the activity sheet. The amount of teacher input at this stage should be as limited as possible to allow for students to become independent in applying their knowledge to unfamiliar situations. This sheet is also provided in an editable format; if you have a particularly high ability class, you may wish to reduce the amount of help. There is also an embedded five-minute timer.

Distillation Demonstration

Slide 8: Show students a simple distillation of ink and water, talking through each piece of apparatus and what happens at each stage. Students should be encouraged to share their initial thoughts with the class before the teacher confirms what happens at each stage.

Distillation Sequencing Cards

Slide 9: Students show their knowledge and understanding of the demonstration by placing sentences in the correct order to explain the stages in distillation. The sequencing cards are differentiated, with the lower ability sheet having the start and end stages already in the correct place, and the higher ability stages all completely mixed up.

Distillation Real World Applications

Slide 10: To contextualise the lesson, there are three **Distillation Real World Applications Information Cards** on one A4 sheet. These should be cut up and placed either around the room, or swapped between students. Students read an information card on either fractional distillation of crude oil, fractional distillation of air or simple distillation of seawater, and complete the matching section on one of two differentiated **Distillation Real World Applications Activity Sheets**.

Distillation Quick Assessment Sheet

Slide 11: Students follow the worksheet to demonstrate their knowledge of distillation by answering exam style questions. There is also a teacher assessment sheet that could be completed after the lesson where formative feedback can be given.

Plenary

Slides 12-13: Ask students to make two lists of 'Apparatus I Knew before Today' and 'Apparatus I Now Know from Today' to allow for reflection, for the acquisition of new vocabulary, and to practise spelling. Remind the students of today's success criteria on slide 14 of the PowerPoint.

Suggested Home Learning

Students could research further into fractional distillation of crude oil in preparation for key stage 4. Alternatively, students could complete the **Distillation Quick Assessment Sheet** if not completed during class time.

Real World Applications of Distillation

Mixture	Questions	Correct?
crude oil	a. State two useful substances in crude oil. b. What is the difference in temperature between the top of the column and the bottom? Please show your working out. c. Why do smaller substances move to the top of the column? d. Which change of state happens as the substances move to the top of the column?	
air	a. Why is air a mixture? b. Which gas has a boiling point of -190°C? c. What could be done to further separate out the oxygen and argon remaining in the fractionating column?	
seawater	a. What do you think 'desalination' means? b. State an advantage of this process. c. State a disadvantage of this process.	

Answers

Mixture	Answers
crude oil	
a	Two from: diesel oil, kerosene and petrol.
b	350 – 25 = 325°C
c	Less energy is needed to overcome the forces between smaller particles, and so it is easier to change them from a liquid to a gas.
air	
a	A mixture is two or more substances that are not chemically bonded together. The particles of oxygen, nitrogen and carbon dioxide, etc. are not bonded together.
b	nitrogen
c	Have a second fractionating column with a smaller range of temperatures to separate out argon from oxygen.
seawater	
a	The removal of salinity/salt.
b	Obtain pure drinking water/large quantities of seawater/plentiful supply.
c	Cost of heating the vast amounts of water/near power plants which could be burning fossil fuels and releasing carbon dioxide into the atmosphere.

Real World Applications of Distillation

Mixture	Questions	Correct?
crude oil	a. State three useful substances in crude oil. b. What is the difference in temperature between the top of the column and the bottom? Please show your working out. c. Why is it called 'fractional' distillation?	
air	a. State two elements found in air. b. Which gas has a boiling point of -190°C? c. What is the problem with the oxygen left at the bottom of the column?	
seawater	a. Why is seawater unsafe to drink? b. Name a place where they use distillation to purify seawater. c. Why don't they use a Bunsen burner to heat the seawater?	

Answers

Mixture	Answers
crude oil	
a	Diesel oil, kerosene and petrol.
b	350 – 25 = 325°C
c	The name 'fractional' is because there are several different parts separated out of the mixture.
air	
a	nitrogen and oxygen
b	nitrogen
c	It still contains argon as they have similar boiling points.
seawater	
a	Seawater contains a high concentration of salt.
b	Middle East/Saudi Arabia
c	The amount of seawater is too large/large volumes.

States of Matter Unit Overview KS3

About This Unit	Lessons
The first part of this unit aims to give pupils an understanding of the particulate nature of matter, the difference in arrangements of particles in solids, liquids and gases based on the particle model, how matter can change from one state to another and the movement of particles in terms of diffusion. The second half of this unit focuses on mixtures, solubility and how mixtures can be separated using a variety of techniques including filtration, evaporation, distillation and chromatography.	

Included in this Pack	Learning Objectives	Topics Covered	Main Pupil Activities
Lesson Presentation **Teaching Ideas** **Solids, Liquids and Gases Activity Sheet** **Solids, Liquids and Gases Quick Assessment Sheet**	To understand that matter can exist in three states.	To define matter. To state the three types of matter. To compare and contrast the three states of matter.	Once pupils have discussed and have shown the key points on 'What is matter?' and 'How do we know it exists,' pupils then work in pairs to identify examples of the three states of matter they can see in the classroom as directed on the **PowerPoint**. Pupils then work in small groups to describe the properties of solids, liquids and gases, guided by questions on the **PowerPoint**. After the properties key points have been outlined on the **PowerPoint**, pupils should be encouraged to complete the **Solids, Liquids and Gases Activity Sheet**, followed by the **Solids, Liquids and Gases Quick Assessment Sheet**. Pupils create a Haiku poem about the key points of the three states of matter as a plenary.
Differentiation	**National Curriculum Aims**	**Resources/Practical Equipment**	
By outcome in the starter, the analogy activity, **Diffusion Activity Sheet**, **Diffusion Mini Assessment Sheet**, the plenary and the suggested home learning - **The Particulate Nature of Matter Homework Sheet**. By task in the analogy activity (support for lower ability pupils and an extension task for higher ability pupils given on the **PowerPoint**).	Physics: • To compare the similarities and differences, including density differences, between solids, liquids and gases. • To describe the differences in arrangements, in motion and in closeness of particles and link this to explaining changes of state, shape and density.		

Included in this Pack

Lesson Presentation

Teaching Ideas

The Particle Model Activity Sheet (differentiated for higher and lower ability)

The Particle Model Quick Assessment Sheet

Learning Objectives

To understand how particles are arranged in the three states of matter.

Topics Covered

To identify the arrangement of particles in each state of matter.

To define density.

To link the arrangement of particles in each state of matter to their properties.

Main Pupil Activities

Once pupils have identified the states of matter within the beach picture on the **PowerPoint** and have recapped the previous lesson, pupils follow the instructions on the **PowerPoint** and work in pairs to place their stationery into how they think the particles are arranged in solids, liquids or gases.

After outlining the history of the particle model and density key points on the **PowerPoint**, pupils are encouraged to write a sentence in their book to compare each picture to a state of matter. Extension tasks are given to allow pupils to create their own comparisons to everyday scenarios, and secondly to include the word 'density' in their analogy.

Once key points on the particle model and gas pressure have been discussed on the **PowerPoint**, pupils should be encouraged to complete one of **The Particle Model Differentiated Activity Sheets**, followed by **The Particle Model Quick Assessment Sheet**.

Pupils follow the instructions on the **PowerPoint** to complete a '3, 2, 1 Lift Off' plenary. Pupils write in their books three keywords, two facts they have learned today and one question about the topic they have.

Differentiation

By outcome in the starter activity, arranging stationery activity, the analogy activity, **The Particle Model Differentiated Activity Sheet**, **The Particle Model Mini Assessment Activity Sheet** and the plenary.

By task in **The Particle Model Differentiated Activity Sheet** (higher and lower ability activity sheets available).

National Curriculum Aims

Physics:

- To compare the similarities and differences, including density differences, between solids, liquids and gases.
- To describe the differences in arrangements, in motion and in closeness of particles and link this to explaining changes of state, shape and density.
- To identify atoms and molecules as particles.

Working Scientifically:

- To understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review.

Resources/Practical Equipment

Lesson Pack

Optional homework: **Particle Model Homework Activity Sheet**.

Included in this Pack

Changing States PowerPoint

Teaching Ideas

Stearic Acid Practical Activity Sheet

Changing States Quick Assessment Sheet

Learning Objectives

To understand how matter can change from one state to another.

Topics Covered

To list the different changes of state.

To identify which change of state is happening.

To describe what happens as matter changes between states.

Main Pupil Activities

Once pupils have discussed what connects the pictures on the PowerPoint and have recapped the previous lesson, pupils follow the instructions on the PowerPoint to identify keywords for changing states.

Pupils should be encouraged to complete the gap fill definitions on the PowerPoint, before being given a brief introduction to the stearic acid practical in order to complete the Stearic Acid Practical Activity Sheet.

Pupils should then be encouraged to complete the five quick questions on the Stearic Acid Practical Activity Sheet, followed by the Particle Model Quick Assessment Sheet. Or they could plot their data as a graph using the prompts on the Stearic Acid Practical Activity Sheet.

Differentiation

By outcome in the starter activity, identifying keywords for changing states activity, Stearic Acid Practical Activity Sheet, Changing States Quick Assessment Sheet and the plenary activity.

By support in the gap fill definition activity. There are letter prompts in the gap fill on the PowerPoint and on the Stearic Acid Practical Activity Sheet. (A pre-drawn results table is also available.)

By task in the gap fill definition activity (extension question on the PowerPoint).

National Curriculum Aims

Physics:

- To describe the differences in arrangements, in motion and in closeness of particles and link this to explaining changes of state, shape and density.
- To describe the difference between chemical and physical changes.
- To explain the changes with temperature in motion and spacing of particles.

Working Scientifically:

- To make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements.

Resources/Practical Equipment

Water bath set to approximately 70°C (before the lesson commences).

Per pair/group of pupils:

Stearic acid in a boiling tube with a thermometer placed inside (placed in the water bath before the lesson commences).

stopwatch

Health and Safety

Schools should prepare their own risk assessments for the stearic acid practical. Common procedures include ensuring pupils are stood up throughout the practical, pupils and staff are wearing goggles, long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. Spilt water should be wiped up immediately to prevent slips and falls. The water bath should have a 'caution – hot water' sign attached.

Pupils are reminded of some of these typical rules on the PowerPoint and also on the Stearic Acid Practical Activity Sheet.

Included in this Pack	Learning Objectives	Topics Covered	Main Pupil Activities
Diffusion PowerPoint Teaching Ideas Diffusion Investigation Activity Sheet Diffusion Quick Assessment Sheet Key Revision Facts Particulate Nature of Matter Homework Sheet	To understand how particles can move from one area to another.	To define diffusion. To explain how diffusion works in terms of the particle model. To predict the movement of particles based on factors.	Once pupils have discussed how the smell of burnt toast moves around the house and doesn't last forever as prompted on the PowerPoint, pupils are introduced to the definition of diffusion and should be encouraged to note this down whilst considering which of the three states of matter could diffuse. Once pupils have watched a demonstration of potassium permanganate in water, pupils should be encouraged to complete the analogy activity on the PowerPoint. Pupils should be allowed access to the five scented balloons in order to complete the first task on the Diffusion Investigation Activity Sheet before continuing onto the rest of the activity sheet. Once the four factors affecting diffusion and the mechanisms behind these are explained, alongside Brownian motion, pupils should be encouraged to complete the Diffusion Quick Assessment Sheet. Following this, pupils should work in pairs to identify the errors in a pretend student's conversation about diffusion on the PowerPoint as a plenary activity.

Differentiation	National Curriculum Aims	Resources/Practical Equipment	Health and Safety
By outcome in the starter activity, analogy activity, Diffusion Investigation Activity Sheet and the plenary activity. By support on the PowerPoint to assist with the synoptic style question 5 on Diffusion Investigation Activity Sheet. Also, the Key Revision Facts Sheet to assist with the suggested homework activity Particulate Nature of Matter Homework Sheet. By task in the definition activity (extension tasks of adding in extra terminology to the definition) and the analogy activity (extension tasks of adding keywords to answers and creating own analogies).	Chemistry: • To define diffusion in terms of the particle model. Physics: • To understand that diffusion in liquids and gases is driven by differences in concentration. • To understand Brownian motion in gases. Working Scientifically: • To make predictions using scientific knowledge and understanding.	A large glass beaker filled with hot water. A large glass beaker filled with cold water. A small amount of potassium permanganate. spatula Safety goggles for pupils and staff. Five different coloured balloons filled with various smells (e.g. coffee, vinegar, milkshake powder etc.) and a personalised teacher answer sheet.	Schools should prepare their own risk assessments for potassium permanganate demonstration. Common procedures include ensuring pupils are stood up throughout the demonstration, pupils and staff are wearing goggles, long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. Spilt water should be wiped up immediately to prevent slips and falls. The glass beaker of hot water should have a 'caution – hot water' sign attached. Schools should prepare their own risk assessments for the scented balloons activity, ensuring staff and students are aware of any food allergies and even rubber/latex allergies.

Included in this Pack	Learning Objectives	Topics Covered	Main Pupil Activities
Lesson Presentation Teaching Ideas Mixtures Activity Sheet Mixtures Quick Assessment Sheet	To understand how mixtures look at a particle level.	To define a mixture and state examples. To compare mixtures to compounds. To model air as a mixture.	Once pupils have discussed whether making a salad is a physical or chemical change and are reminded of the differences between these (on the PowerPoint), pupils observe a teacher led demonstration of iron filings and sulfur powder as separate elements, which are then heated and combined into a compound. Pupils should then be encouraged to complete a definitions cloze style activity and then apply this to four particle pictures as prompted on the PowerPoint. Once pupils have been introduced to the notion of mixtures and justified some examples on the PowerPoint, they should be encouraged to complete the Mixtures Activity Sheet where access to coloured sticky dots or coloured pens is required. After this, pupils should complete the Mixtures Quick Assessment Sheet. As a plenary, pupils should apply today's knowledge and keywords to a case study on a smart memory alloy called nitinol on the PowerPoint.

Differentiation	National Curriculum Aims	Resources/Practical Equipment	Health and Safety
By outcome in the starter, justifying mixtures pictures activity, Mixtures Activity Sheet, Mixtures Quick Assessment Sheet and the plenary activity. By support in the definitions activity (letter prompts on the PowerPoint to support with writing the definition of a mixture for lower ability pupils), identifying mixtures activity (use of a periodic table to help identify elements for lower ability pupils), and justifying mixtures activity (use of notes to justify pictures of mixtures for lower ability pupils). By task in the definition activity (higher ability pupils can create own definition of a compound), in the identifying activity (higher ability pupils can name the elements and compounds present in the pictures), and an extension activity on fractional distillation on the Mixtures Activity Sheet for higher ability pupils.	Chemistry: • To describe the differences between atoms, elements and compounds. • To define a mixture. • To state chemical reactions as the rearrangement of atoms. Physics: • To describe the difference between chemical and physical changes.	Access to a gas tap. safety goggles Bunsen burner heatproof mat Small magnet covered in cling film to stop iron filings from adhering. Weighing boat or a watch glass. Small amount of sulfur powder (approximately 4g). Small amount of iron filings (approximately 7g). Note: only heat 2g of the combination of iron filings and sulfur from the 7:4 ratio above. One heatproof glass test tube. Mineral wool plug for end of test tube. One pair of test tube tongs or boss and clamp and clamp stand. Small circular 'sticky dots' in five different colours (approximately one small sheet per pupil) or five different coloured felt tips.	Schools should prepare their own risk assessments for the iron filings and sulfur powder demonstration. Common procedures include ensuring pupils are stood up throughout the demonstration, pupils and staff are wearing goggles throughout due to the fine nature of the iron filings, long hair is tied back and no food or drink is consumed. The room should be well ventilated and asthmatics should be known to staff and notified beforehand, due to the sulfur vapours produced. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. The Bunsen burner should be positioned in the centre of the desk and tongs should be used to hold the test tube into the flame, with the mineral wool plug pointing away from any person. A damp rag should be nearby to extinguish the sulfur vapours to prevent them from catching fire and placed over the mineral wool plug if needed.

Included in this Pack	Learning Objectives	Topics Covered	Main Pupil Activities
Lesson Presentation **Teaching Ideas** **Planning an Experiment into Solubility Activity Sheet (differentiated for higher and lower ability)** **Solubility Quick Assessment Sheet**	To plan an investigation on solubility.	To define keywords in the solubility topic. To apply solubility keywords to situations. To design a safe and valid experiment. To describe how temperature affects solubility.	Once pupils have discussed three questions surrounding adding sugar to a cup of tea as prompted on the **PowerPoint**, pupils should be encouraged to draw a cup of tea and annotate the three keywords 'solute', 'solvent' and 'solution' next to each part of the tea. Two additional keywords are also introduced and pupils should be encouraged to note these down. Pupils then follow one of the differentiated **Planning an Experiment into Solubility Activity Sheets** to plan a safe and valid experiment into dissolving sugar in water at different temperatures. If time, resources and your school permit, pupils can also perform this experiment during the lesson. This should be followed by the **Solubility Quick Assessment Sheet**. As a plenary activity, pupils are shown three pictures and asked to spot as many keywords in the pictures as prompted on the **PowerPoint**.

Differentiation	National Curriculum Aims	Resources/Practical Equipment	Health and Safety
By outcome in the starter, keyword activity, **Planning an Experiment into Solubility Activity Sheets**, **Solubility Quick Assessment Sheet** and the plenary. By support in **Planning an Experiment into Solubility Activity Sheet** (differentiated for higher and lower ability) and also the level of teacher or teaching input to complete the activity sheet. Also if the practical is performed in this lesson, the level of teacher or teaching assistant input in order to safely carry out the practical.	Chemistry: • To define a mixture and dissolving. Working Scientifically: • To select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables. • To use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety. • To make predictions using scientific knowledge and understanding.	If students finish planning the experiment and there is time to carry it out, they will need the following per pair or small group: • a small bag of sugar; • three small 25ml glass beakers; • one glass rod; • access to hot water/a kettle; • one thermometer.	Schools should prepare their own risk assessments if pupils carry out the solubility practical this lesson. Common procedures include ensuring pupils are stood up throughout the experiment, pupils and staff are wearing goggles, long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. Spilt water should be wiped up immediately to prevent slips and falls and especially near electrical sockets on desks. The source of hot water (e.g. kettle) should have a 'caution – hot water' sign attached.

Included in this Pack

Lesson Presentation

Teaching Ideas

Filtration Invention Activity Sheet

Filtration Invention Peer Assessment Grid

Filtration Quick Assessment Sheet

Learning Objectives

To understand how filtration works and its everyday importance.

Topics Covered

To define keywords relating to filtration.

To apply keywords to real-life situations.

To design a filter and communicate ideas clearly.

Main Pupil Activities

Once pupils have discussed what links the five pictures on the **PowerPoint** and have been given a brief introduction to filtering and shown examples, pupils should be encouraged to note down the four keywords, 'filter', 'filtrate', 'residue' and 'filtration', and their definitions.

After being given background information on dirty water, pupils should then gather into small groups to complete the **Filtration Invention Activity Sheet** to design a water filter and prepare a sales 'pitch' to present to the class. If time permits during the lesson, all pitches could be presented to the class, with the teacher acting as the 'investor'. There is also a **Peer Assessment Grid** for pupils to complete upon watching their classmates' presentations and pupils could vote for their favourite pitch.

Afterwards, pupils should complete the **Filtration Quick Assessment Sheet**.

As a plenary, pupils think of six keywords from today's lesson and write them in order of importance as shown on the diagram, similar to a 'diamond nine' activity.

Differentiation

By outcome in the starter, **Filtration Invention Activity Sheet**, **Filtration Quick Assessment Sheet** and the plenary.

By support with the **Filtration Invention Activity Sheet** - teacher or teaching assistant input to help with filtration invention, alongside pre-written scaffolded sales pitch structure for lower ability pupils.

By task in the keywords activity - extension task of drawing filtering apparatus, and applying keywords to the diagram for higher ability pupils.

National Curriculum Aims

Chemistry:

- To describe simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

Working Scientifically:

- To ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience.
- To use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety.
- To make predictions using scientific knowledge and understanding.

Resources/Practical Equipment

Included in this Pack

Lesson Presentation

Teaching Ideas

Separating Salt from Rock Salt Activity Sheet (differentiated for higher and lower ability)

Separating Salt from Rock Salt Practical Teacher Feedback Grid

Evaporation Quick Assessment Sheet

Differentiation

By outcome in the starter, **Separating Salt from Rock Salt Activity Sheet**, discussing the formation of salt lakes, **Evaporation Quick Assessment Sheet** and the plenary.

By support on the **Separating Salt from Rock Salt Activity Sheet** (a method is pre written for lower ability pupils) and also the level of teacher or teaching assistant input to safely carry out the practical for lower ability pupils.

By task on the **Separating Salt from Rock Salt Activity Sheet** - a task of sequencing a method is given to higher ability pupils. Also, the final question of the plenary where higher ability pupils are encouraged to think why some of the steps for making copper sulfate crystals are different to making pure salt crystals.

Learning Objectives

To understand how to use evaporation as a separation technique.

National Curriculum Aims

Chemistry:

- To describe simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

Working Scientifically:

- To evaluate risks.
- To select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables.
- To use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety.

Topics Covered

To identify scientific apparatus.

To safely follow a method.

To apply keywords to a practical.

Resources/Practical Equipment

Rock Salt Practical - pupils will need the following per pair or small group;

- rock salt;
- pestle and mortar;
- 2 x 250ml glass beakers;
- funnel and filter paper;
- glass rod;
- heatproof mat;
- Bunsen burner;
- tripod;
- evaporating basin.

Optional: Premade copper sulfate crystals in a sealed petri dish for pupils to observe as part of the plenary activity.

Main Pupil Activities

Once pupils have completed the starter literacy task by making as many words out of 'evaporation' as possible in three minutes, pupils are given a recap about mixtures, including the definition, and how they link to separation techniques.

Pupils are reminded of the definition and conditions of evaporation, with pictorial support of the arrangements of particles in a liquid compared to a gas. A brief background on rock salt is presented to the class, and pupils then follow one of the differentiated **Separating Salt from Rock Salt Activity Sheets** to carry out a safe practical, with the aim of separating pure salt from rock salt. There are questions to answer at the end of the practical.

Pupils are shown pictures and information about salt lakes and halophiles to make synoptic links to biology. Pupils are shown how evaporation can occur on large scales. Pupils should then complete the **Evaporation Quick Assessment Sheet**.

As a plenary activity, pupils are shown a picture of copper sulfate crystals on the **PowerPoint**, and if possible, have some ready to observe in a sealed petri dish to pass around the class. Pupils are shown a pictorial method on the **PowerPoint** for making copper sulfate crystals. In pairs, they should try to spot the similarities and differences between their rock salt practical in today's lesson and the copper sulfate method.

Health and Safety

Schools should prepare their own risk assessments for the rock salt practical. Common procedures include ensuring pupils are stood up throughout the demonstration, pupils and staff are wearing goggles throughout due to the fine nature of the iron filings, long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. Pestle and mortars, and evaporating basins should also be handled with care and broken pieces disposed of carefully by staff. The Bunsen burner should be positioned in the centre of the desk, on top of a heatproof mat and only packed away once cooled down.

Schools should prepare their own risk assessments for the copper sulfate crystal observation. Common procedures include ensuring the copper sulfate crystals are in a sealed petri dish.

Included in this Pack

- Lesson Presentation
- Teaching Ideas
- Distillation Apparatus Activity Sheet
- Distillation Sequencing Cards (differentiated for higher and lower ability students)
- Distillation Information Cards
- Distillation Real World Applications Activity Sheet (differentiated for higher and lower ability students)
- Distillation Quick Assessment Sheet

Differentiation

By outcome in the starter, Distillation Apparatus Activity Sheet, Distillation Sequencing Cards, Distillation Real World Applications Activity Sheet, Distillation Quick Assessment Sheet and the plenary.

By support in the distillation demonstration (the teacher can vary input and type of questioning), on the Distillation Sequencing (beginning and end steps in the correct order for lower ability students) and on the differentiated Distillation Real World Applications Activity Sheet – there are more scaffolded and accessible questions for lower ability students compared to more challenging questions for higher ability students.

Learning Objectives

To understand how to use distillation as a separation technique.

National Curriculum Aims

Chemistry:

- To describe simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

Working Scientifically:

- To make predictions using scientific knowledge and understanding.
- To interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions.

Topics Covered

To identify scientific apparatus.

To explain how distillation works.

To recognise the everyday uses of distillation.

Resources/Practical Equipment

Distillation apparatus needed for demonstration:

- Access to gas tap and water tap (in close proximity to each other).
- Safety goggles for the teacher and all students.
- Small amount of ink mixed with water.
- Bunsen burner
- heatproof mat
- Tripod and gauze (if required)
- Distilling flask/round bottomed flask
- thermometer
- Condenser with rubber tubes attached.
- glass beaker
- Clamp stands and bosses

Main Pupil Activities

Once pupils have described the picture on the PowerPoint using as many keywords from this topic as they can in two minutes, pupils are then given a recap of the two separation techniques covered so far.

Pupils follow the Distillation Apparatus Activity Sheet to apply their knowledge of changing states and scientific apparatus to guess what happens in distillation, guided by the questions on the activity sheet with no teacher input.

Once pupils have watched a teacher led demonstration of simple distillation of ink and water, pupils should be encouraged to complete the differentiated Distillation Sequencing Cards by placing sentences in the correct order to explain the stages in distillation.

To contextualise the lesson, there are three Distillation Real World Applications Information Cards, which could be cut up and placed either around the room, or swapped between pupils. Pupils read an information card on either fractional distillation of crude oil, fractional distillation of air or simple distillation of seawater and complete the matching section on one of the differentiated Distillation Real World Applications Activity Sheet.

Pupils should then complete the Distillation Quick Assessment Sheet.

As a plenary, pupils are prompted to make two lists of 'Apparatus I Knew before Today' and 'Apparatus I Now Know from Today'.

Health and Safety

Schools should prepare their own risk assessments for the simple distillation of ink and water demonstration. Common procedures include ensuring pupils are stood up throughout the demonstration, pupils and staff are wearing goggles, long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. The Bunsen burner should be positioned in the centre of the desk and all glassware should be fixed securely in place. The production of hot water, and therefore steam, should be noted by the teacher in case of burns and scalds, and apparatus should be left to cool before packing away.

Included in this Pack

Lesson Presentation

Teaching Ideas

Solving Crimes Using Chromatography Activity Sheet

Chromatography Quick Assessment Sheet

Learning Objectives

To understand how to use chromatography as a separation technique.

Topics Covered

To create a chromatogram.

To explain how chromatography works.

To recognise the everyday uses of chromatography.

To identify different separation techniques.

Main Pupil Activities

Once pupils have listed colours in their chosen section of the picture on the PowerPoint and identified any primary and secondary colours, pupils are shown a recap about the three separation techniques covered in the topic so far and given a brief introduction to the chromatography, using solubility key words and also given a brief history of technique.

Pupils are then shown a six step sequence of how to perform chromatography on the PowerPoint. This could also be modelled by the teacher simultaneously to show pupils how to set up and create a chromatogram. Pupils are then introduced to the chromatography mystery to solve using the PowerPoint slides and the pre-made chromatogram should be shown to the class as a reference, in order for pupils to then complete the Solving Crimes Using Chromatography Activity Sheet.

To contextualise the lesson, pupils are asked to discuss and then discover how chromatography is used in a variety of different ways and pupils should then be encouraged to complete the Chromatography Quick Assessment Sheet. As a plenary activity, pupils could work in pairs to identify the four separation techniques as shown on the PowerPoint (A to D). Pupils must then decide which technique to use in each situation described, to separate out the mixture. There is also a challenge question asking pupils to explain why they chose that technique to justify their answers.

Differentiation

By outcome in the starter, Solving Crimes Using Chromatography Activity Sheet, Chromatography Quick Assessment Sheet and the plenary.

By support with the Solving Crimes Using Chromatography Activity Sheet (the level of teacher or teaching assistant support required to safely complete the chromatography practical and associated questions) and also in Chromatography Real World Applications on the PowerPoint (the level of teacher input to elicit ideas on real world applications of chromatography).

By task in starter activity (a task of identifying primary and secondary colours is given), in Chromatography Real World Applications on the PowerPoint (if the teacher wishes to generally discuss gas chromatography with higher ability students) and in the plenary on the PowerPoint (students are asked to justify their answers as an extension task).

National Curriculum Aims

Chemistry:

- To describe simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

Working Scientifically:

- To pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility.
- To make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements.
- To interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions.

Resources/Practical Equipment

- ruler
- pencil
- three black pens
- A pre-made chromatogram using one of the above pens (water soluble only) to be used as Mr Rye's reference chromatogram.

Each student will need:

- a strip of chromatography or filter paper;
- a small glass beaker;
- a spare pencil or piece of straw and a drawing pin;
- a small amount of water or ethanol to use as the solvent;
- safety goggles.

Health and Safety

Schools should prepare their own risk assessments for the chromatography demonstration and class practical. Common procedures include ensuring pupils and staff are wearing goggles (particularly if ethanol is used), long hair is tied back and no food or drink is consumed. Ensure all bags and coats are safely put away. Glassware should be handled carefully and broken pieces disposed of by staff. Ethanol should be administered by staff in the smallest volume possible. The vapours of ethanol should not be inhaled and the room should be well ventilated. Ethanol is also highly flammable. Methylated spirit (IDA) is also highly flammable, as well as being harmful. Neither ethanol nor methylate spirit should be used near naked flames. Make sure equipment for extinguishing fires is nearby.

Included in this Pack

States of Matter Student Revision Checklist

Properties of Solids, Liquids and Gases Cut and Stick Activity Sheet

Solids, Liquids and Gases Match and Draw Activity Sheet

Particles and States of Matter Glossary

Solids, Liquids and Gases 'If I Was' PowerPoint

Changes of State Match and Draw Activity Sheet

Changes of State 'Can You Guess' Cards

Changing States PowerPoint Quiz

States of Matter Crossword

States of Matter Assessment Package

Learning Objectives

To consolidate knowledge of the particle model and changes of state.

Topics Covered

To self-assess progress in this topic.

To further strengthen and deepen knowledge of this topic.

To apply knowledge to exam style questions.

Main Pupil Activities

Suggested outline of the lesson:

Starter: Students complete States of Matter Student Revision Checklist or Progress Sheet 1 in the States of Matter Assessment Package in order to identify their areas of strength and areas of improvement, which will be worked on during today's lesson.

Main Activities: Students should choose two or three activities to complete from a mixture of demands (listed in order of increasing demand):

Properties of Solids, Liquids and Gases Cut and Stick Activity Sheet (low demand)

Changes of State Match and Draw Activity Sheet (low demand)

Solids, Liquids and Gases Match and Draw Activity Sheet (low demand)

Particles and States of Matter Glossary (mid demand)

States of Matter Crossword (mid demand)

Changes of State 'Can You Guess' Cards (mid/high demand)

Test Yourself 1, 2 and 3 Activity Sheets in the States of Matter Assessment Package (high demand)

Absent or lower ability students may find the Key Revision Facts sheet in the States of Matter Assessment Package helpful.

These activities should be punctuated by teacher input every 10 to 15 minutes to perform a whole class activity from the following:

Solids, Liquids and Gases 'If I was' PowerPoint

Changing States PowerPoint Quiz

Students should then complete the Exam Style Questions in the States of Matter Assessment Package and self-assess their answers.

Students could take home a copy of Progress Sheet 2 in the States of Matter Assessment Package to help organise their revision.

Differentiation

By outcome in the main activities, whole class activities and the exam style questions.

By support in terms of teacher or teaching assistant input during the main activities and also access to the Key Revision Facts sheet in the States of Matter Assessment Package for lower ability or absent students.

By task in the choice of main activities.

National Curriculum Aims

Chemistry:

- To describe the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure.
- To explain changes of state in terms of the particle model.

Physics:

- To state the conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving.
- To explain the changes with temperature in motion and spacing of particles.

Resources/Practical Equipment

Optional: Mini whiteboards for Changing States PowerPoint Quiz and Solids, Liquids and Gases 'If I was' PowerPoint.

Included in this Pack

Separation Techniques Student Revision Checklist

Solute, Solvent and Solution Match and Draw Activity Sheet

Separating Techniques Match and Draw Activity Sheet

Mixtures Glossary

Pure and Impure Substances 'Can You Guess?' Cards

Separating Mixtures Circular Dominoes

Separation PowerPoint Quiz

Pure and Impure PowerPoint Quiz

Separating Techniques 'If I Were' PowerPoint

Separation Techniques Assessment Package

Learning Objectives

To consolidate knowledge of mixtures, solubility and the four separation techniques.

Topics Covered

To self-assess progress in this topic.

To further strengthen and deepen knowledge of this topic.

To apply knowledge to exam style questions.

Main Pupil Activities

Suggested outline of the lesson:

Starter: Students complete **Separation Techniques Student Revision Checklist** or **Progress Sheet 1** in the **Separation Techniques Assessment Package** in order to identify their areas of strength and areas of improvement, which will be worked on during today's lesson.

Main Activities: Students should choose two or three activities to complete from a mixture of demands (listed in order of increasing demand):

Solute, Solvent and Solution Match and Draw Activity Sheet (low demand)

Separating Techniques Match and Draw Activity Sheet (low demand)

Mixtures Glossary (mid demand)

Pure and Impure Substances 'Can You Guess?' Cards (mid/high demand)

Separating Mixtures Circular Dominoes (mid/high demand)

Test Yourself 1, 2 and 3 Activity Sheets in the Separation Techniques Assessment Package (high demand)

Absent or lower ability students may find **the Key Revision Facts** sheet in the **Separation Techniques Assessment Package** helpful.

These activities should be punctuated by teacher input every 10 to 15 minutes to perform a whole class activity from the following:

Separation PowerPoint Quiz

Pure and Impure PowerPoint Quiz

Separating Techniques 'If I Were' PowerPoint

Students should then complete the **Exam Style Questions** in the **Separating Techniques Assessment Package** and self-assess their answers.

Students could take home a copy of **Progress Sheet 2** in the **Separating Techniques Assessment Package** to help organise their revision.

Differentiation

By outcome in the main activities, whole class activities and the exam style questions.

By support in terms of teacher or teaching assistant input during the main activities and also access to the **Key Revision Facts** sheet in the **Separating Techniques Assessment Package** for lower ability or absent students.

By task in the choice of main activities.

National Curriculum Aims

Chemistry:

- To describe the differences between atoms, elements and compounds.
- To define a mixture and dissolving.
- To state chemical reactions as the rearrangement of atoms.
- To describe simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

Resources/Practical Equipment

Optional: Mini whiteboards for **Separation PowerPoint Quiz, Pure and Impure PowerPoint Quiz** and **Separation Techniques 'If I was' PowerPoint.**