Writing a clear method

Name ________________________________ **Class** ____________ **Date** ______________

1 Here are some rules for writing an experimental method well. Choose words from the word box to complete each rule correctly.

A Each step should describe just one _______________.

B The steps should be written in _______________ (in the correct order).

C Correct science terms should be used for processes and _______________.

D Use a _______________ instead of words if it describes what to do more clearly.

E Use imperative verbs to keep sentences simple and to keep the ______________ clear.

apparatus	action	diagram	language	sequence

2 Here is a method that describes getting into a car. This method needs improving.

A First you unlock the car.
B Then you open the car door.
C Then you put the seat belt on and close the car door.
D Then you sit in the car seat.

a Underline the verbs in each step.

b Rewrite steps A and B using imperative verbs. (Remember an imperative verb is one that tells you to do something.)

A ____

B ____

c The sequence of steps C and D is wrong. Explain why.

____

d Step C is also not good because it contains two different instructions. It would be better as two separate steps, each one describing a different action.

Rewrite steps C and D as steps C to E, so that they are in the right sequence and each step describes just one action.

C ____

D ____

E ____

3 Write a method to describe how you would cook something simple, such as frozen peas, or microwave a ready-cooked meal. Remember to use the rules for writing good instructions.

A ____

B ____

C ____

D ____

E ____

I can…

- structure a method in a clear manner.

Name ______________________________ Class ____________ Date _____________

1 Draw a line from each type of mixture to its description.

Type of mixture	Description
suspension	A cloudy mixture where the solid doesn't settle out of the liquid if left to stand still.
colloid	A mixture in which the solid is dissolved in the liquid.
solution	A mixture where the solid settles out of the liquid if left to stand still.

2 Waste water is filtered to help clean it. What is removed from the water in this process?

Circle the correct term.

dissolved solids   large suspended solids   dispersed solids

3 The box shows the three states of matter.

solid	liquid	gas

Styrofoam™ is a colloid that contains polystyrene and air (as shown in photo B in the Student Book). In what state are the polystyrene and air in this colloid? Choose one word from the box for each answer.

a polystyrene ___________________

b air ___________________

4 Imagine a jar of dirty water (or look at Photo D in the Student Book).

Complete the sentence.

You can see that dirty water is a colloid because it is ___________________.

I can…

- identify different types of mixture
- identify the states of matter for substances in a mixture.

Ordering a method

Name ______________________ **Class** ____________ **Date** ____________

I can…

- develop logical sequences of points in writing.

Cut out the statements below.

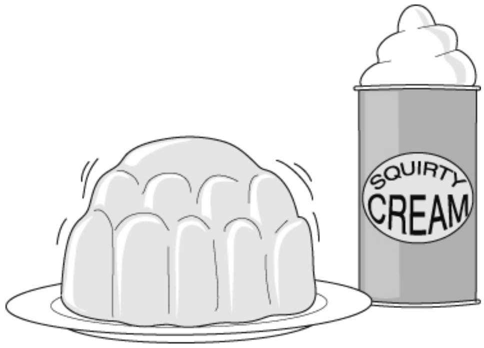
- Sort them into the right order, to show the stages in filtering a mixture of sand and water.
- Check the order with your teacher.
- When the order is correct, stick them into your workbook.

Carefully pour the sand/water mixture into the filter paper.
Fold the filter paper in half, and then into quarters.
Leave the apparatus to stand until all the liquid in the mixture has filtered into the flask.
Open out one layer of the filter paper to make a cone.
Place the filter paper cone into the wide end of the funnel.
Put the narrow end of the funnel into the top of the flask.

Other types of mixture

Name ______________________________ **Class** ____________ **Date** _____________

A **suspension** is a mixture in which the substances will separate when left to stand, such as sand and water.
A **colloid** is a mixture where the substances don't separate when left to stand.



The small bits of solid in a colloid may be too small to be seen under normal conditions, but may show up when a beam of light shines on them. You can see this effect when headlights are used in fog. The tiny drops of water are suspended in the air and reflect some of the light. You will probably be familiar with many colloids, even if you don't realise it!

There are many different types of colloid. They are given different names depending on what state the substances are in the mixture. The table shows how different colloids are classified.

	Substance 1	
Substance 2	**solid**	**liquid**
liquid	sol (solid in liquid) or gel (liquid in solid)	emulsion
gas	aerosol (solid in gas) or solid foam (gas in solid)	aerosol (liquid in gas) or foam (gas in liquid)

You will be given examples of different kinds of colloids that are in everyday use. Use the table to identify the type of colloid shown in each example.

Use what you find to prepare a chart or poster that shows examples of each kind of colloid.

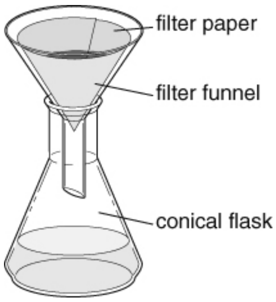
I can …

- classify different kinds of mixtures.

Apparatus diagrams

Name ______________________________ **Class** ____________ **Date** _____________

This picture shows apparatus used for filtering.



This diagram uses symbols for the apparatus.

1 Write down *two* ways in which the picture and diagram are similar.

1st way ____

2nd way ____

2 Write down *two* ways in which the picture and diagram are different.

1st way ____

2nd way ____

3 Why is it easier to draw the apparatus as a diagram rather than as a picture?

____

____

4 The diagram is drawn using symbols that all scientists use. Why does it help if everyone uses the same symbols?

____

____

5 Copy the apparatus *diagram* at the top of the sheet in the space below. Use a sharp pencil and a ruler to keep your diagram neat. Label each piece of apparatus.

I can…

- use agreed scientific conventions appropriately

The right steps

Name ______________________________ **Class** ____________ **Date** _____________

1 A student wrote a method for filtering soil out of muddy water. The steps she wrote in her method were not as good as they could be.

Rewrite each step below so it is clearer and another student can follow the instructions.

A Fold the filter paper and stick it into the funnel.

____

____

B The funnel goes in the container.

____

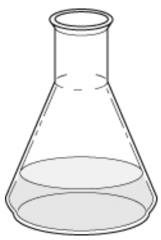
____

C When I poured the water in at the top, clean water came out at the bottom and the mud was the stuff left in the filter.

____

____

2 The drawings on the left are pieces of apparatus that are used for filtering. Draw the symbols for the apparatus in the boxes on the right. Remember to use a sharp pencil and a ruler.

Apparatus	Symbol
 **filter funnel and paper**	
 **conical flask**	

3 Explain why scientists draw apparatus diagrams using two-dimensional symbols and not three-dimensional pictures.

____

____

I can…

- present ideas about science clearly
- use agreed scientific symbols appropriately.

Name ______________________________ Class ____________ Date _____________

1 A mixture of flour shaken with water is a suspension. Which *two* statements are true about this mixture? Tick *two* boxes.

☐ The flour dissolves in the water.

☐ The flour is a solid and the water is a liquid.

☐ The flour will settle to the bottom of the container if the mixture is left to stand.

☐ The flour will stay dispersed in the water and will not settle out if left to stand.

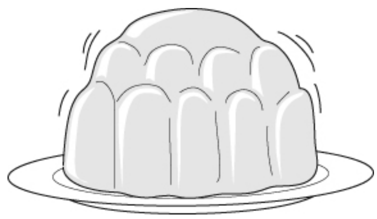
2 The pictures show some examples of colloids. For each colloid, identify the state of each substance in it. Choose words from the box.

solid	liquid	gas

colloid of hairspray and air

state of hairspray: ____________________

state of air: ____________________



colloid of gelatine and water

state of gelatine: ____________________

state of water: ____________________

3 Here are some objects made of colloids and some useful properties. Draw a line from each object to the useful property of the colloid from which it is made.

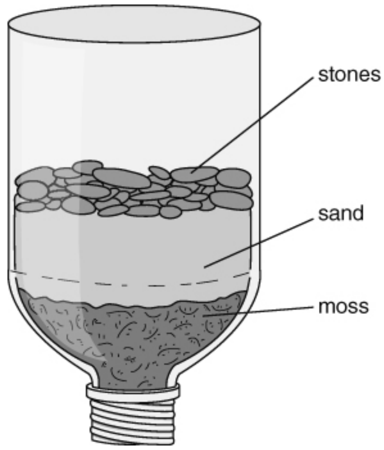
Object	**Useful property**
Styrofoam™ cup	The water helps it to spread more thinly.
hairspray	The water is absorbed and locked away.
gel in a disposable nappy	The air stops heat passing quickly through.
hand cream (skin softener in water)	The air spreads the liquid droplets so you don't get too much in one place.

I can…

- identify different kinds of mixture
- identify the states of matter for substances in a mixture.

An emergency water filter

Name ______________________________ **Class** ____________ **Date** _____________



Some students designed an emergency water filter for use on a wilderness expedition. They started with the top part of a large plastic bottle without the bottle cap. They tested a range of materials from the surroundings to find a combination that produced the cleanest water. They found that pushing each material down into the end of the bottle helped to make the filter work better.

The diagram shows their final design.

1 Draw an apparatus diagram for laboratory apparatus that could be used to filter dirty water.

Remember to:

- use the correct (two-dimensional) symbol for each piece of apparatus
- use a sharp pencil to draw your diagram
- use a ruler to draw straight lines
- label each piece of apparatus clearly.

2 Use the description above and the diagram to write a method for preparing this emergency filter.

Remember to:

- use clear and simple language
- make sure each instruction covers just one step of the method
- make sure that the instructions are in the correct order.

3 Explain why the emergency filter could clean dirty water.

4 Explain why the filtrate from this filter would need further treatment before it was safe for drinking.

I can…

- use agreed scientific symbols appropriately
- present scientific ideas clearly.

Different kinds of colloids

Name ________________________________ Class _____________ Date ______________

Colloids are mixtures that contain a dispersed substance in another substance, which is often called the continuous substance. For example, in dirty water, small bits of mud or soil are dispersed in water.

Each of the substances in a colloid may be a solid, a liquid or a gas. Colloids are classified into the groups shown on the right depending on the state of the dispersed substance and of the continuous substance.

aerosol	foam	emulsion	sol	gel

1 Identify the state of matter of each substance in the following colloids.

- hairspray is a liquid aerosol of liquid hair lacquer in air
- mayonnaise is an emulsion of liquid egg yolk in oil
- smoke is a solid aerosol of tiny solid bits in air
- dessert jelly is a gel of water in solid gelatine
- Styrofoam™ is a solid foam of air bubbles in solid polystyrene
- some coloured inks are sols of tiny solid pieces dispersed in water
- whipped cream is a liquid foam of air bubbles in liquid butterfat.

2 Use your answers to Question 1 to help you design a table that can be used to identify types of colloids, depending on the states of matter of the substances.

3 Use your table to identify the type of colloid made by the following mixtures.

- hand cream is mostly a mixture of oils and water
- dirty water
- fog is made from droplets of water in air
- pumice is a stone full of air bubbles.

4 Milk is a mixture of droplets of butterfat and water. If milk straight from the cow is allowed to stand, the butterfat will rise to the top leaving the watery part below. Before bottling, the milk is usually homogenised. This breaks the butterfat droplets into smaller and smaller droplets and helps to stop the fat separating.

a What kind of mixture is milk straight from the cow? Explain your answer.

b What kind of mixture is homogenised milk? Explain your answer.

c Use the information and your answers to justify whether classifying substances, as in the table you produced for Question 2, is helpful or not.

I can…

- classify mixtures.

Solution words and definitions

Name ______________________ Class __________ Date ___________

- Cut out the words and the definitions and match them up.
- Stick the correct pairs in your book.

I can…

- identify the meaning of terms related to solutions.

Word cards

dissolves	soluble	transparent
insoluble	solution	solute
solvent	saturated	solubility

Definition cards

A liquid in which other substances dissolve.	A mixture formed when a substance dissolves in a liquid.	The amount of substance that dissolves in a given amount of liquid.
See-through.	When a substance splits up and mixes with a liquid to make a solution.	Something that will dissolve in a liquid.
Something that will not dissolve in a liquid.	When a solution contains the most solute that will dissolve in the solvent.	The substance that has dissolved in a liquid to make a solution.

Solvents and solutions

Name ____________________ **Class** ____________ **Date** ____________

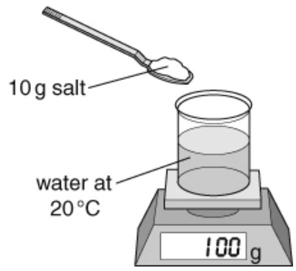
At 20 °C, 36 g of salt will dissolve in 100 g of water. At 100 °C an additional 3 g of salt will dissolve in 100 g of water.

- Cut out the drawings and labels.
- Match up each lettered drawing with a numbered drawing to show what happens next. You do not need to use all the numbered drawings.
- Put the correct label with each pair of drawings to explain what is happening.

I can…

- identify what happens when a solute is added to a solvent.

A



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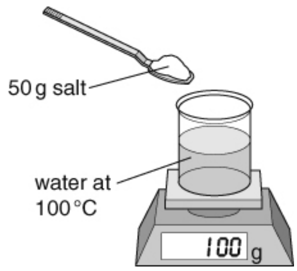

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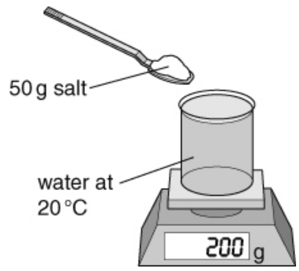

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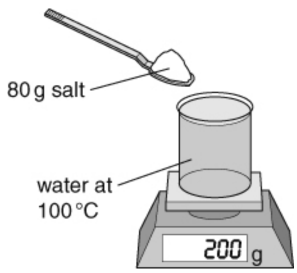

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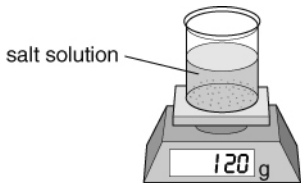

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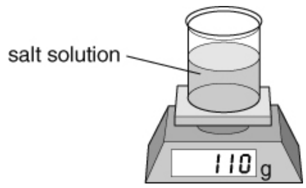

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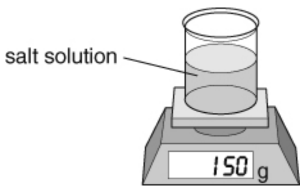

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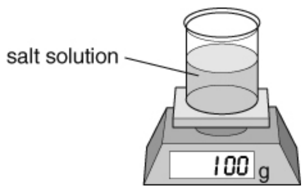

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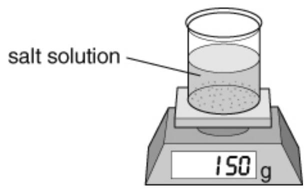

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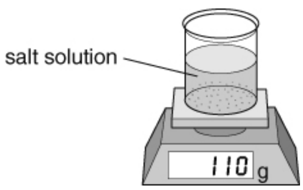

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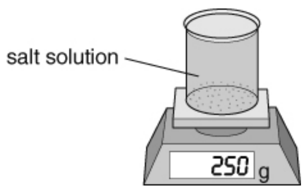

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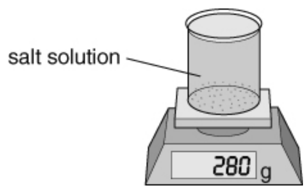


a The salt has dissolved in the water.

a The salt has dissolved in the water.

b The salt solution is saturated.

b The salt solution is saturated.

Temperature and solubility 1

Name ______________________________ **Class** ____________ **Date** ____________

Your teacher may watch to see if you can:

- measure temperatures using a thermometer.

Fill in the gaps in these sentences, using words from the box. You will need to use some words more than once.

beaker	dissolved	repeat	white substance
same	sink	spatulas	thermometer

Aim

I am going to find out how much ________________ dissolves in water at different temperatures.

Apparatus

- beaker
- thermometer
- spatula
- eye protection
- white substance
- glass rod
- water baths at 30 °C and 50 °C

⚠ Wear eye protection.

Method

A Measure 20 cm^3 of water into a ___________________ using a measuring cylinder.

B Measure the temperature using a ___________________, and write it in the table.

C Add a spatula of white substance and stir it until it has ___________________.

D Add another spatula of ___________________ and keep stirring.

E ___________________ this until no more will dissolve.

F Write down the number of ___________________ of white substance that was added.

G Pour the solution down the ___________________ and put some clean water into the beaker.
This will be a fair test because it uses the ___________________ amount of water.

H Heat the water to 30 °C, and find out how many spatulas of white substance dissolves in it.

I ___________________ the experiment at 50 °C.

Recording your results

Temperature (°C)	Number of spatulas of white substance
room temperature (__)	
30	
50	

Considering your results/conclusions

___________________ (more/less) white substance dissolves in water if the water is hot.

Evaluation

Suggest two ways you could have made your investigation better, and explain why these would make the investigation better.

____

____

____

I can…

- plan a fair test on dissolving
- draw a conclusion from evidence.

Temperature and solubility 2

Your teacher may watch to see if you can:
- follow instructions
- use equipment safely and carefully.

Method

A Pour 10 cm^3 of water into a boiling tube.

B Use a spatula to place 3 g of copper sulfate into the tube.

C Place the tube into a rack in one of the water baths to heat the water very gently, and shake the tube gently until all the copper sulfate has dissolved.

D Place a thermometer in the solution and allow time for it to reach the temperature of the solution.

E Remove the tube from the water bath and, as the solution cools down, write down the temperature when you first see crystals appearing.

F Calculate the solubility of the copper sulfate at the temperature you recorded in g/100 cm^3 of water. (Hint: You used 10 cm^3 of water. 100 cm^3 of water is 10 $\times$ 10 cm^3. So, the mass of copper sulfate that will dissolve in 100 cm^3 is 10 $\times$ the mass you measured.)

G Repeat steps A to F for 4 g, 5 g, 6 g and 7 g of copper sulfate.

Apparatus
- boiling tube + rack
- measuring cylinder
- spatula
- copper sulfate crystals
- balance
- eye protection
- thermometer
- water baths at a range of temperatures up to 70 °C

⚠ Wear eye protection.
Do not point the open end of the tube towards another student.

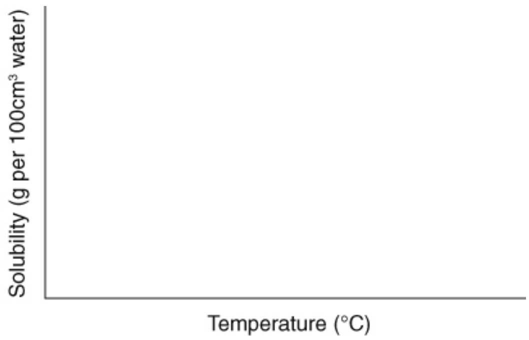
Remember that solubility is in g/100 cm^3.

Recording your results

1 Draw a table to record your results.

2 Plot a scatter graph to show your results. Use axes like the ones on the right. You don't need to draw lines to link the points.

Think carefully when you are drawing your graph – make sure the axes allow a good spread of the data points.



Considering your results/conclusions

3 As the temperature increases describe how the solubility of copper sulfate changes with temperature.

Evaluation

4 Describe how you would improve this investigation if you had time to do it again, and explain why your changes would be an improvement.

I can…
- draw a conclusion from evidence
- identify patterns using scatter graphs.

Graphing solubility 1

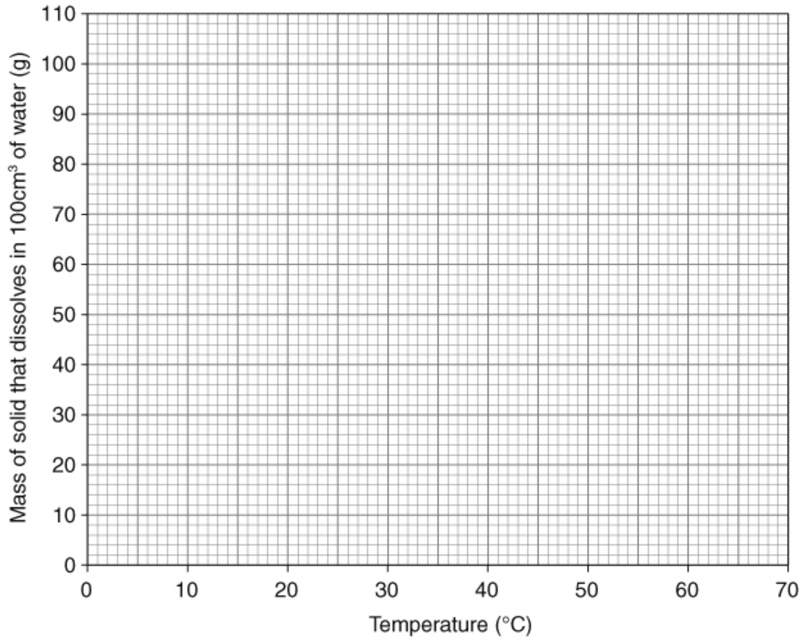
Name ______________________________ **Class** ____________ **Date** _____________

The table shows how well two substances (potassium nitrate and potassium chloride) dissolve in water at different temperatures. The 'solubility' is the number of grams that dissolve in 100 cm^3 of water

Temperature (°C)	Solubility of potassium nitrate (g/100 cm^3)	Solubility of potassium chloride (g/100 cm^3)
10	20	32
20	30	35
30	44	36
40	60	38
50	78	40
60	100	42

1 Plot a line graph to show these results.

- Choose a different colour for each solid, and show these in the key.
- Plot the points on the graph, and join the dots with straight lines.



Key: ☐ potassium nitrate ☐ potassium chloride

2 Use your graph to help you answer the questions. Choose the correct words or numbers from the brackets.

a When the temperature goes up, the mass of solid that dissolves ______________________ (goes up/goes down/stays the same).

b At 10 °C, more potassium __________________(chloride/nitrate) dissolves.

c At 40 °C, more potassium __________________ (chloride/nitrate) dissolves.

d At 55 °C, you would expect _________________ (31/36/41/48) grams of potassium chloride to dissolve.

e To get 70 grams of potassium nitrate to dissolve, you would need to heat the water to about

______________________ (25/35/45/55) degrees.

I can…

- draw and interpret a line graph.

Graphing solubility 2

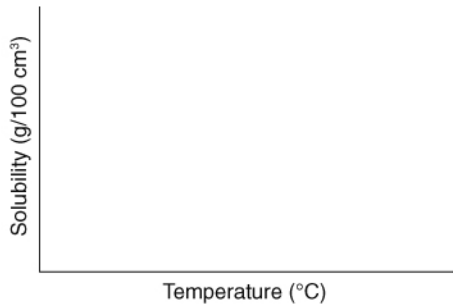
Name ______________________ Class __________ Date ___________

The table shows how well two substances (potassium nitrate and potassium chloride) dissolve in water at different temperatures. The 'solubility' is the number of grams that dissolve in 100 cm^3 of water.

Temperature (°C)	Solubility of potassium nitrate	Solubility of potassium chloride
10	20	32
20	30	35
30	44	36
40	60	38
50	78	40
60	100	42

1 Draw a line graph to show this information. Use axes like those shown on the right.

- Choose a different colour for each solid, and show these in a key.
- Plot the points on the graph, and join the dots with straight lines.



2 Use your graph or the table to help you answer these questions.

a How does the solubility of the substances change as the temperature changes?

b Which substance is the most soluble at 10 °C?

c Which substance is the most soluble at 40 °C?

d This table shows how hot 100 cm^3 of water would have to be to dissolve certain amounts of potassium nitrate.

Copy this table, and use your graph to help you to fill in the gaps.

Mass of chemical (g)	Temperature of water (°C)
20	10
25	
30	20
35	
40	
45	
50	
55	
60	40

I can…

- draw and interpret a line graph.

Name ________________________ Class __________ Date __________

1 Cross out the wrong word in each bold pair, so that the sentences are completed correctly.

a Salt is **insoluble / soluble** in water, because it dissolves.

b Nail varnish is **insoluble / soluble** in water, but **insoluble / soluble** in propanone.

2 For each of the following solutions,

a draw a circle around the solvent

b underline the solute.

solution 1: a solution of water and copper sulfate

solution 2: a solution of nail varnish and propanone.

3 Tick the box that shows the correct meaning of the term *solubility*.

☐ The amount of solute that dissolves in a particular amount of water.

☐ The temperature of a solution when the solute dissolves.

☐ The amount of solute that dissolves in a particular amount of solvent.

☐ The volume of solvent that dissolves the solute.

4 The table shows the results from an investigation into how many spatulas of sodium nitrate dissolved in 100 cm^3 of water at different temperatures.

Temperature of water (°C)	10	25	40	55
Number of spatulas	3	5	7	9

a Tick the box that best describes what the results show.

☐ Sodium nitrate is insoluble in water.

☐ The amount of sodium nitrate that dissolves in water increases as temperature increases.

☐ The speed at which sodium nitrate dissolves in water increases as temperature increases.

☐ The amount of sodium nitrate that dissolves in water decreases as temperature increases.

b If a 6th spatula full of sodium nitrate was added to the beaker at 25 °C, would the sodium nitrate have dissolved?

yes / no

c Explain your answer to part **b**.

____

I can…

- explain how soluble substances form clear solutions
- describe the effect of temperature on solubility.

Name ________________________________ **Class** _____________ **Date** ______________

Copper chloride forms solid crystals. Ethanol is a form of alcohol. When 20 g of copper chloride is added to a beaker containing 200 g of ethanol at 25 °C and the mixture is stirred, the crystals get smaller and disappear.

1 Why do the copper chloride crystals disappear? ____________________________________

2 The solubility of copper chloride in ethanol is 67 g in 100 g of ethanol at 15 °C. What would you see if you added the following amounts of copper chloride to ethanol and stirred? Explain your answers.

a 61 g copper chloride to 100 g ethanol at 15 °C

____

b 76 g copper chloride to 100 g ethanol at 15 °C

____

c 60 g copper chloride to 60 g ethanol at 15 °C

____

d 76 g copper chloride to 100 g ethanol at 25 °C

____

3 In the mixture of copper chloride and ethanol, which substance is the solvent and which is the solute? Explain your answers.

____

4 **a** What is the mass of the contents of the beaker after the copper chloride has disappeared?

____

b Explain your answer to part **a**.

____

5 The solubility of copper chloride in ethanol is 53 g in 100 cm^3 at 15 °C.

What would you see if you added the following amounts of copper chloride to ethanol and stirred? Explain your answers.

a 48 g copper chloride to 100 cm^3ethanol at 15 °C ____________________________________

____

b 60 g copper chloride to 100 cm^3 ethanol at 15 °C ____________________________________

____

c 48 g copper chloride to 60 cm^3 ethanol at 15 °C ____________________________________

____

d 60 g copper chloride to 100 cm^3 ethanol at 25 °C ____________________________________

____

I can…

- explain how soluble substances form clear solutions.
- describe the effect of temperature on solubility.

Name ______________________ **Class** __________ **Date** __________

Like most solids, gases also dissolve in water. Fish and other animals and microorganisms that live in the water need oxygen, and they use some of the dissolved oxygen in the water.

The table shows the solubility of oxygen in fresh water and in sea water at different temperatures. The units are milligrams of oxygen per 1000 cm^3 of water. (1 mg is 1/1000 gram)

Temperature (°C)	Solubility of oxygen (mg/100 cm^3)	
	Fresh water	Sea water
0	14.6	11.5
10	11.3	9.0
20	9.1	7.4
30	7.5	6.2
40	6.4	5.4
50	5.5	4.6
60	4.7	4.0

1 Plot a line graph to show the solubility of oxygen at different temperatures. Put temperature on the horizontal axis and solubility on the vertical axis. Plot the lines for fresh water and salt water on the same axes.

Use your graph to help you to answer these questions.

2 **a** What happens to the solubility of oxygen as the temperature increases?

b How does this compare with the change in solubility of most solids as the temperature increases?

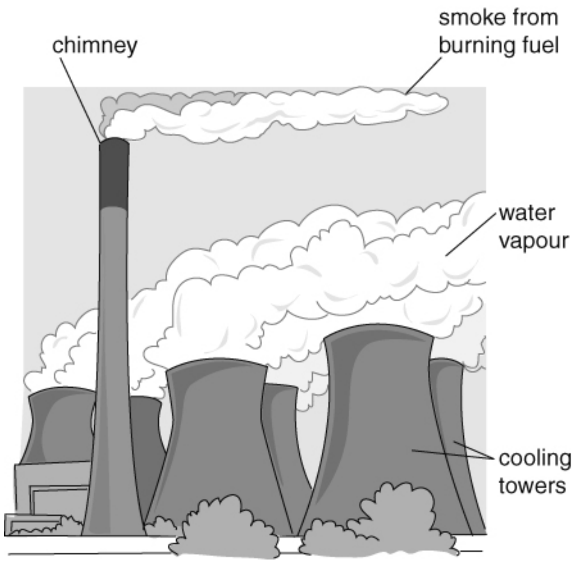
3 **a** Is oxygen more soluble in fresh water or in sea water?

b Which changes most as you increase the temperature – the solubility in fresh water or in sea water? Explain your answer.

4 **a** What is the solubility of oxygen in fresh water at a temperature of 5 °C?

b How hot would the fresh water need to be for oxygen to be only half as soluble as it is at 5 °C?

Power stations use steam to turn generators to produce electricity. The steam has to be cooled down again. One way of doing this is to use water from a nearby river to cool the steam. The water could be put back into the river afterwards, but it would be a lot warmer than it was before. Instead of doing this, power stations use cooling towers, where the water warmed by the steam is cooled as it falls down the tower.



5 If warm water from power stations was put back into rivers, how would this affect fish living in the river?

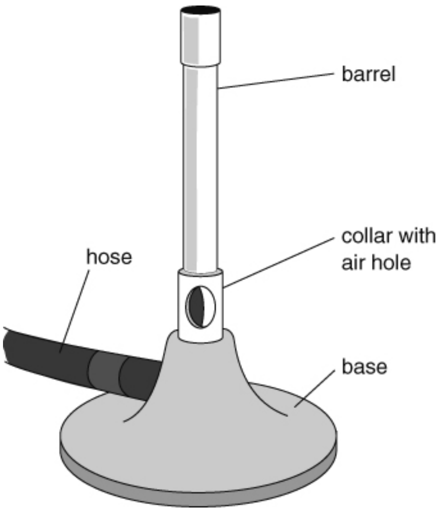
6 Nuclear power stations are often built on the coast. They use sea water for cooling steam, and put the warm water back into the sea. Suggest why this is not as harmful for sea fish as it would be for fish living in rivers. (*Hint:* there are *two* reasons.)

I can…

- describe the effects of different variables on solubility
- apply information about solubility to different contexts
- draw and interpret a line graph.

Name ______________________ Class ____________ Date ____________

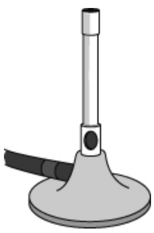
1 Draw lines to link the labels on the diagram of a Bunsen burner to their functions.

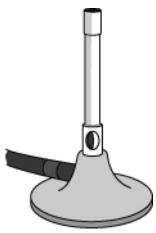


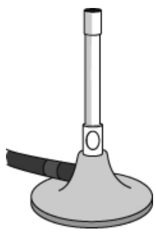
supplies gas to burner
lifts flame to useful height for heating
keeps the burner stable on a flat surface
controls how much air mixes with gas

2 Use the correct colour of pencil to add the flame to each of these Bunsen burner drawings. Remember to draw the correct size of flame, as well as the correct colour.

a flame for heating strongly **b** flame for gentle heating **c** safety flame







3 a Describe one hazard of heating with a Bunsen burner.

____

b Describe what you could do to reduce the risk of being harmed by that hazard.

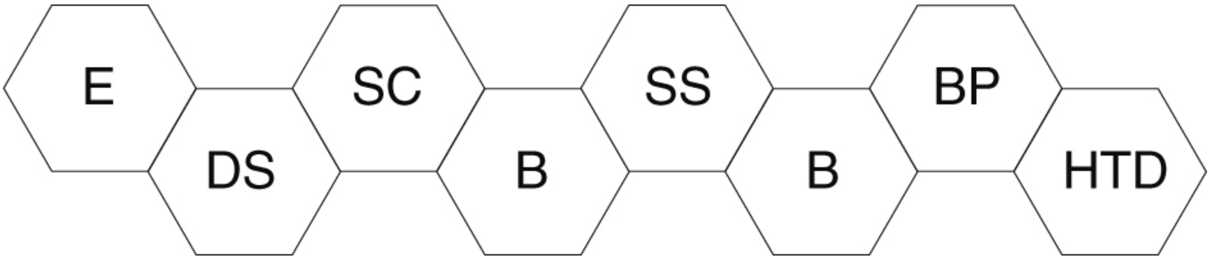
____

____

I can…

- describe how a Bunsen burner is used
- identify hazards and describe how to reduce the risks from them.

Name ______________________________ **Class** ____________ **Date** _____________



1. What E happens when a liquid turns to gas only at its surface? ________________________
2. What DS is left behind when a solution is heated? ________________________
3. Which SC is a substance found in rock salt? ________________________
4. What B means salty water? ________________________
5. What SS is made by evaporating sea water? ________________________
6. What B is when all parts of a liquid are turning into a gas at once? ________________________
7. Which BP is the temperature at which a liquid boils? ________________________
8. What HTD is the way to recover the solutes from a solution? ________________________

I can…

- describe how solutes can be separated from a solution by evaporation
- describe differences between evaporation and boiling.

Name ______________________________ **Class** ____________ **Date** _____________

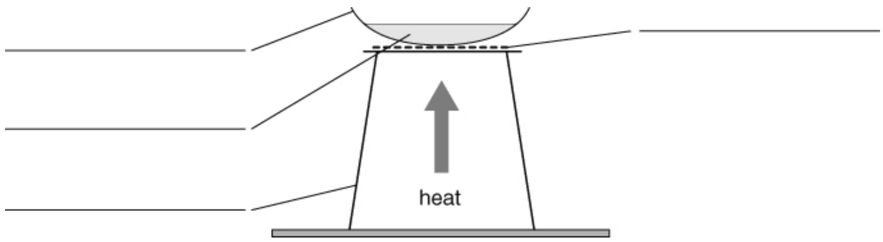
Method

Apparatus

- evaporating basin
- heat-resistant mat
- gauze
- water samples
- tripod
- Bunsen burner
- eye protection

⚠ Always wear eye protection when heating.

Label this diagram using words from the apparatus list.



Fill in the missing words below, using words from the box. You will need to use some of the words more than once.

evaporated	evaporating	evaporating basin	mass
measuring cylinder	same		

A Separate the water from the salt by __________________________ the water.

B To make this a fair test, use the __________________________ amount of water each time.

C Measure the volume of the water using a __________________________.

D Calculate the __________________________ of salt by measuring the mass of the evaporating basin when all the water has __________________________.

E Wash the salt out of the __________________________ and then do the experiment again with the other sample of water, using the __________________________ evaporating basin.

Recording your results

Sample	Mass of basin and salt
A	
B	
C	

Considering your results/conclusion

Sample __________________________ had the most salt in it.

I know this because it had the greatest mass.

I can…

- describe how to heat to dryness safely
- describe how to make a test fair.

Name ______________________ **Class** __________ **Date** __________

All water samples contain substances that have dissolved in the water as it flowed through the ground.

You will be given some samples of water to investigate. Your task is to find out which water sample has the most substances dissolved in it. You will need to separate the substances from the water.

You must carry out a fair test. Make sure that you work carefully, because another group may be checking your results.

Apparatus

- evaporating basin
- eye protection
- Bunsen burner
- tripod
- water samples
- gauze
- balance
- heat-resistant mat

⚠ Always wear eye protection when heating.

Planning

1 Write a plan for your investigation. Show it to your teacher before you start.

You will need to think about these things:

- How much water will you use?
- How will you remove the water from the other substances?
- How will you know how much substance your samples contain?
- How will you make your experiment safe?
- How will you be able to check if your results are correct?

Recording your results

2 Present your results in a table.

Considering your results/conclusion

3 Which sample contained the most substances?

4 How do you know this?

Evaluation

5 How could you improve your method if you had time to do the investigation again? Explain your answer.

I can…

- plan an investigation into evaporation
- describe how to make a test fair
- plan appropriate safety precautions for heating to dryness.

Name ________________________________ Class _____________ Date ______________

When salt is dug from the ground, it comes out of the ground as rock salt. Rock salt is a mixture of solid rock and salt. You can get the salt out of rock salt in the lab.

Method

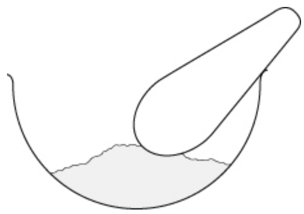
Apparatus

- rock salt
- evaporating basin
- mortar and pestle
- tripod
- 2 beakers
- gauze
- stirring rod
- heat-resistant mat
- funnel
- Bunsen burner
- filter paper
- eye protection

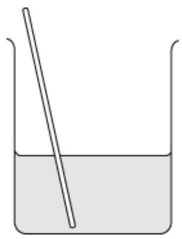
⚠ Wear eye protection.

Wear eye protection.

A Crush some rock salt using the mortar and pestle.



B Put the crushed rock salt into a beaker and add some water. Stir the mixture.



C Carefully filter the mixture. The liquid that comes through the filter paper should be clear.

D Put a little liquid in an evaporating basin and heat it. Stop heating when crystals start forming around the edge of the solution and let the last of the water evaporate without heating. Otherwise, salt will start spitting out of the basin as it dries.

E The powder that is left in the evaporating basin should be salt.

1 Describe how you obtained salt from rock salt.

2 Draw a neat diagram to show how you evaporated the liquid.

3 Why did you crush the rock salt in step **A**?

4 What happened to the salt in the rock salt when you added water?

5 When you filtered the mixture, what was left in the filter paper?

6 Why didn't filtering remove the salt from the water?

I can …

- describe how solutes can be separated from a solution by evaporation.

Name ______________________ Class __________ Date __________

Rock salt is a mixture of rock and salt. The instructions below are mixed up.

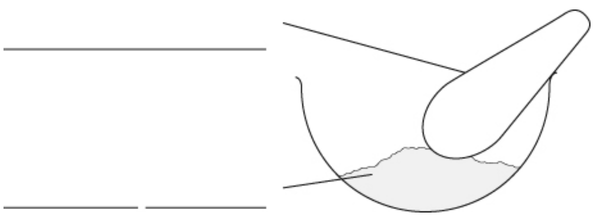
- Cut out the cards and arrange them in order to describe how to make salt from rock salt.
- Add labels to the diagrams. The words you need are in the box. You will need some words more than once.

beaker	bits of rock	conical flask	evaporating basin	funnel	heat
pestle	pure salt	rock salt	salty water	stirring rod	tripod

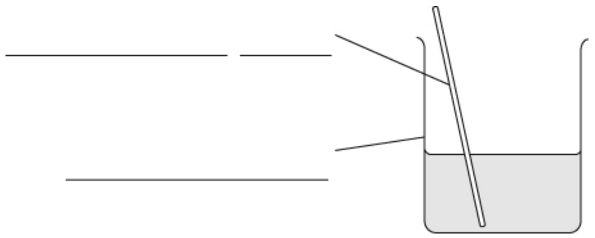
I can…

- describe how to separate a soluble solid from a solution.

1



2



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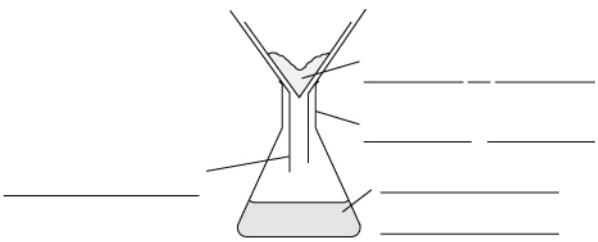

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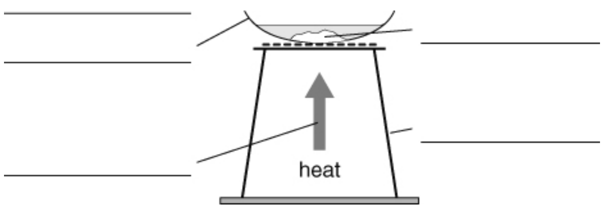


A Filter the mixture.

B Crush up the rock salt using a mortar and pestle.

C The insoluble bits of rock will be trapped in the filter paper. Salty water will go through the filter paper.

D You can get the salt from the salty water by evaporating the mixture.

E Put the crushed-up rock salt into a beaker and add water.

F This makes sure that there is no salt trapped inside bits of rock.

G The salt is soluble and will dissolve. The bits of rock are insoluble and will not dissolve.

H The water evaporates and leaves the salt behind.

I The filter paper does not trap the salt because the salt is dissolved in the water.

J Stir the mixture to help the salt to dissolve.

Dissolved salts in water

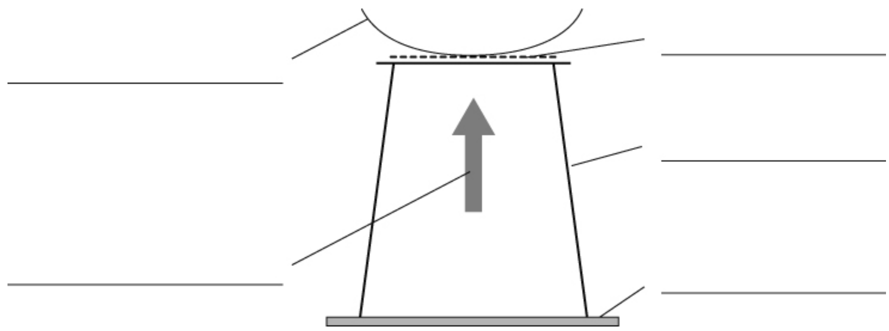
Name ______________________ Class ____________ Date ____________

An experiment tested three different bottled waters to see which contained the most dissolved solids. A bottle of each water was evaporated to see how much solid matter was left.

1 The diagram shows the apparatus used in the experiment. Label the apparatus using words from the box.

Apparatus

- evaporating basin
- heat-resistant mat
- heat
- safety gauze
- tripod



2 **a** Identify one hazard with using this apparatus in this experiment.

____

b Describe what you could do to reduce the risk of this hazard.

____

3 The table shows the results from the experiment.

Bottled water	1	2	3
Mass of solids (mg)	19.8	41.2	25.4

Note: 1 mg = 1/1000 g

a Describe how you would present these results as clearly as possible.

____

b Tick the box that shows how the experiment was a fair test.

☐ The water was heated for the same time.

☐ The same volume of each water was evaporated.

☐ The water was heated in the same evaporating basin each time.

☐ Each water was heated to the same temperature.

c Water that contains a lot of dissolved solids is described as being 'hard'. Water that does not contain a lot of dissolved solids is said to be 'soft'. Which bottled water was 'hardest'? Explain your answer.

____

____

I can…

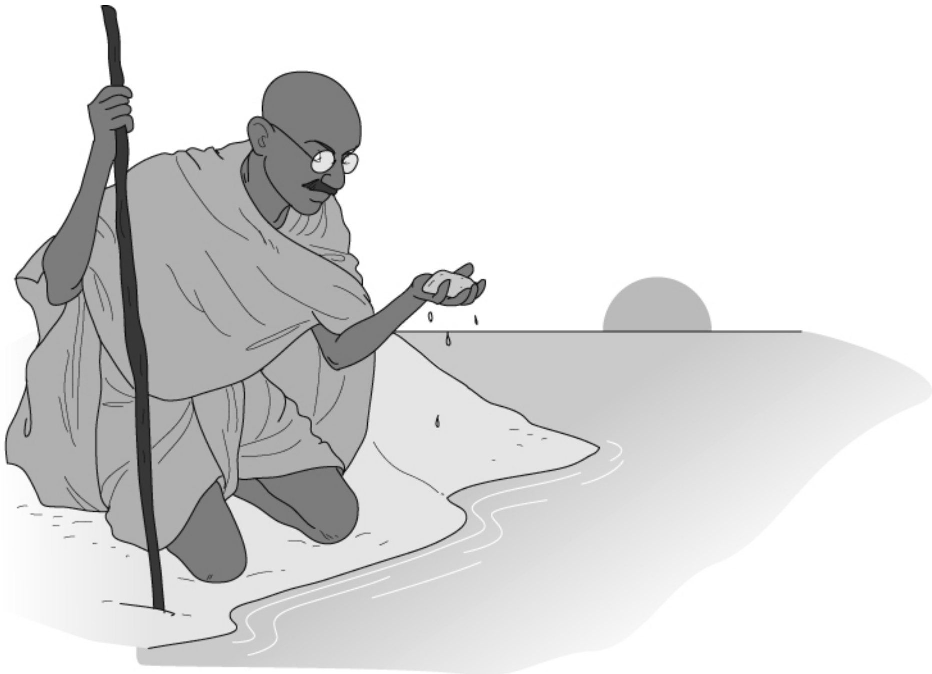
- identify hazards and describe how to reduce the risks from them.

Name ______________________________ Class ____________ Date _____________

When the British ruled India at the beginning of the twentieth century, they passed laws to ban the Indians from making their own salt.

In March 1930, Mahatma Gandhi went to the edge of the sea and picked a pinch of salt from the sand. Thousands of Indian people quickly followed his example and made their own salt by taking a pan of sea water and letting the Sun evaporate the water.

Many people were arrested for doing this but eventually the law was changed again to allow anyone to make their own salt.



1 Why did people make salt from the sea water instead of picking the salt up from the beach as Gandhi had done?

2 Would the salt that these people made contain just one substance? Explain your answer.

3 In some countries there are salt lakes, which sometimes dry up in the summer. If you collected salt from the lake bed it would be mixed with sand. Design a method to separate the sand from the salt, using normal laboratory apparatus.

- Draw a diagram to illustrate each stage in your method.
- Explain why you need to carry out each step of the process.
- Identify any hazards in your method, and suggest ways to reduce any risks.

I can…

- describe how solutes can be separated from a solution by evaporation
- identify hazards and describe how to reduce the risks from them.

Carry out a risk assessment

Before any science experiment can be carried out in school, the teacher must complete a full risk assessment. This includes:

- identifying hazards from the apparatus and substances used in the experiment
- identifying hazards caused by a large number of people working in the same space
- thinking about the level of risk caused by these hazards, e.g. low, medium or high
- identifying ways of reducing the risks
- identifying actions needed if something goes wrong.

Using one of the experiments you have done recently that included heating and evaporation, write a full risk assessment for the experiment carried out by a whole class of students in a school science lab.

Use the bulleted points above to help you structure your risk assessment. Your teacher will supply any hazard information for the substances used in the experiment.

EXPLORING SCIENCE WORKING SCIENTIFICALLY 7 Ec-9

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I can…

- identify hazards and describe how to reduce the risks from them.

How does chromatography work?

Name ______________________ **Class** __________ **Date** __________

Draw lines to link the phrases to describe how chromatography works.

Chromatography can separate ...	... by seeing how many different colours are on the chromatogram.
A drop of the mixture ...	... different coloured dyes in a mixture.
The bottom of the paper ...	... is put into a solvent such as water.
The solvent dissolves the dyes and ...	... is put onto a piece of special chromatography paper.
The different dyes in the mixture ...	... to make a chromatogram.
The paper is dried ...	... are carried at different speeds in the solvent.
You can work out the number of different dyes in the mixture ...	... travels up the paper.

I can…

- describe how chromatography can be used to separate substances in a mixture.

A chromatography method

Name ________________ Class ________ Date ________

When you write a method for a chromatography experiment, you will need to think about the following questions. Use your answers to help you make sure the experiment works as well as possible.

1 How can you make sure that the colours will be strong enough to see when they have separated?

____

2 If you mark the starting line, how will you make sure it won't disappear?

____

3 Where should you put the dots of colour, and why?

____

4 How can you make sure you are using the right solvent for the substances you will try to separate?

____

5 If you are comparing several samples, how can you make sure they won't run into each other?

____

6 How can you make sure the paper won't collapse into the solvent when it is wet?

____

7 Are there any safety instructions needed to reduce the risks from hazards?

____

When you write your method, remember to write an apparatus list for everything you will use.

Also draw an apparatus diagram, using the correct symbols, to show how the apparatus should be set up.

I can…

- present ideas using clear points
- describe how chromatography can be used to identify substances in a mixture.

Different kinds of chromatography

Name ______________________________ Class ____________ Date _____________

I can…

- state examples of where chromatography is used
- explain how chromatography works.

The text below describes two different chromatography methods. Choose one of the methods and use the information given to prepare a poster that describes as clearly as possible in words and diagrams how the method is carried out and what it is used for.

Illustrate your poster using suitable diagrams from below, your own drawings or diagrams from other sources such as the internet. You could add other information from your research.

Gas-liquid chromatography

Gas-liquid chromatography can be used to separate tiny amounts of gases or liquids. The mixture is put into a special machine.

Gas is added to the mixture to carry it through the machine.

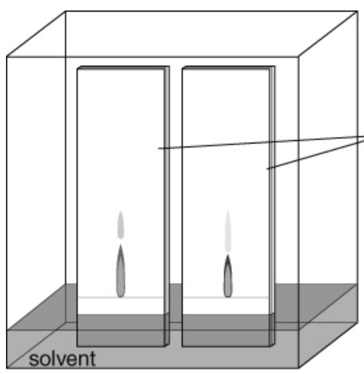
Different substances in the mixture take different times to go through the machine. The machine detects each substance and produces a graph. Each peak on the graph represents the amount of substance that is detected.

Thin-layer chromatography

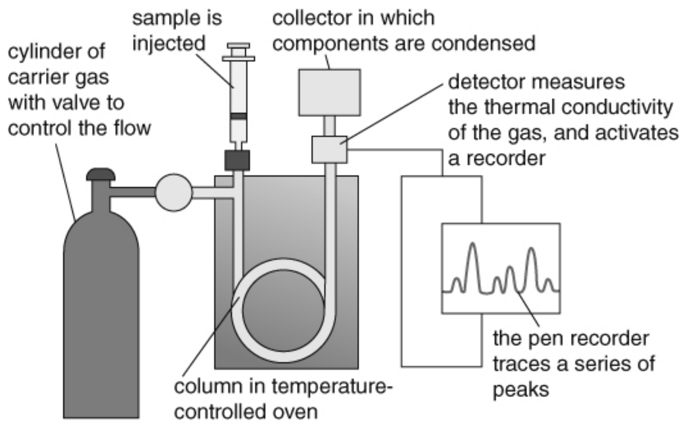
A glass or plastic plate is coated with a thin layer of a special powder, which sticks to the plate. Spots of different mixtures are put on the plate and the bottom of the plate is placed in a solvent.

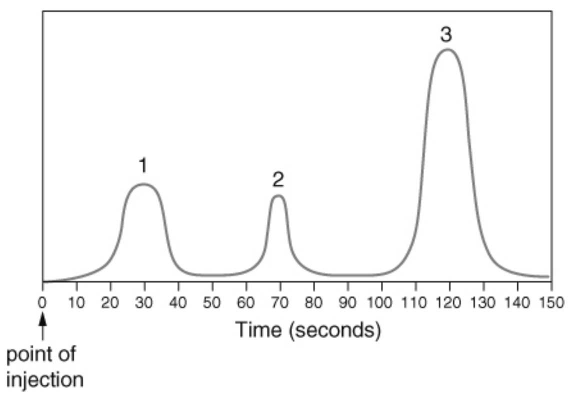
As the solvent spreads up the powder layer, different substances in each mixture are carried at different speeds by the solvent.

After separation, colourless substances may be identified by spraying with locating agents that make them coloured, or by shining ultraviolet light on them to make them glow.

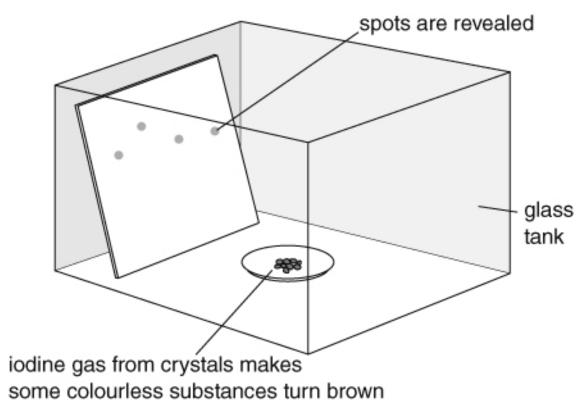


Two chromatograms made with a thin layer of silica spread on glass plates.





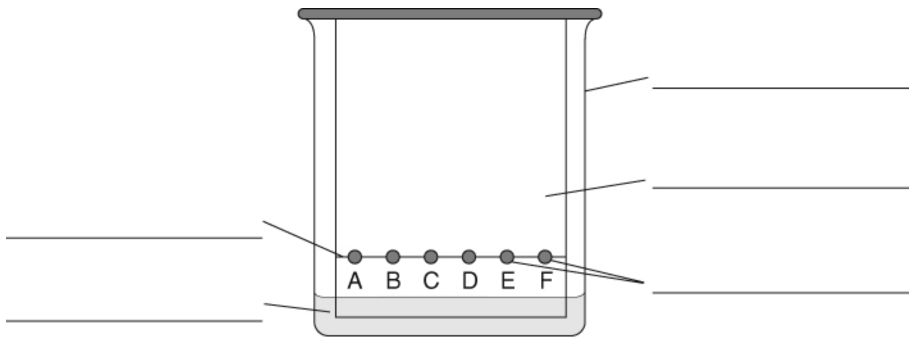
This graph shows that the mixture contained three different substances.



Name ______________________ **Class** __________ **Date** __________

Drawing A shows the apparatus that Sam used for making a chromatogram. She used six different-coloured inks.

A

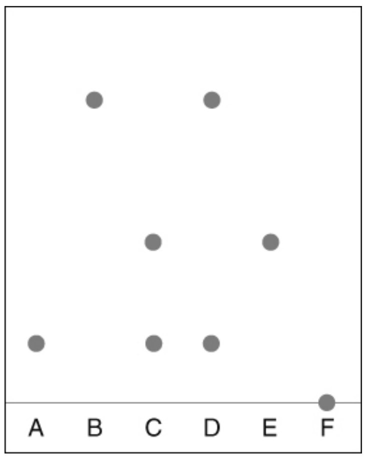


1 Label the apparatus using words from the box.

beaker	paper	pencil line	spots of ink	water

Drawing B shows what the finished chromatogram looked like.

B



2 Three of the inks have only one colour in them.

a Which three are they? ______________________

b Explain your answer. ______________________

____

3 a Which inks are mixed to make ink C? ______________________

b Which inks are mixed to make ink D? ______________________

4 a Which ink was not soluble in water? ______________________

b Explain your answer. ______________________

I can…

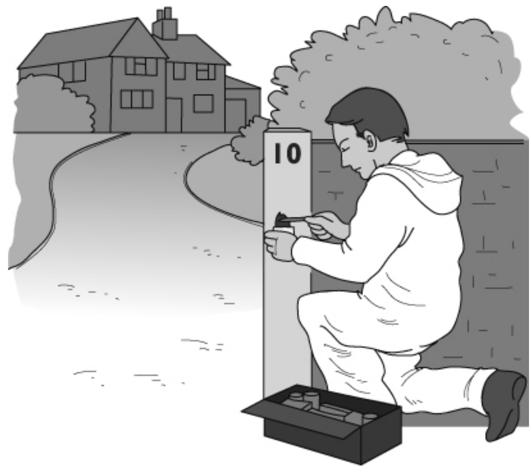
- Interpret a chromatogram.

Who scraped the gatepost?

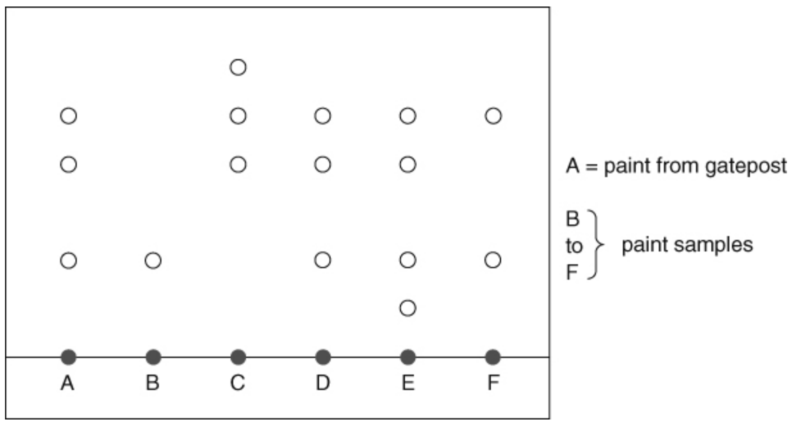
Name ______________________________ **Class** ____________ **Date** _____________

Police were called to 10 Manor Road because there had been a burglary. There were some bits of red paint on the gatepost, and the police suspected that the robbers' car or van scraped against the gatepost when they were making their getaway.

A forensic science laboratory was asked to find out what make of car the burglars had used. Different car manufacturers use different mixtures of colours in their paint. The scientists used chromatography to find out the make of the getaway vehicle.



These are the results of the tests:



1 The scientists did not use water as a solvent when they carried out their tests. Why not?

2 Which manufacturer (or manufacturers) used one pure colour in their red paint?

3 Which manufacturer (or manufacturers) used a mixture of only two colours?

4 Which manufacturer (or manufacturers) used a mixture of three colours?

5 Which manufacturer uses the same paint as the paint from the gatepost?

The chromatography test does not *prove* that the getaway vehicle was made by the manufacturer in your answer to question **5**. Post Office vans are red, so the marks could have been made when a parcel was delivered.

6 How could you show that the paint did not come from a Post Office van?

7 If the police found a vehicle that they suspected had been used in the burglary, what could they check to see if they were right?

I can…

- Describe how chromatography can be used to identify substances in a mixture.

Gas chromatography in water analysis

Name ________________________________ **Class** _____________ **Date** ______________

It is essential that water companies test their water to make sure it is safe for drinking. Water samples for testing are taken just after treatment, and from taps in houses and offices. Different kinds of chromatography are used on the water, depending on the substances to be analysed. One technique is gas chromatography, which is used to detect tiny amounts of substances in water, including pesticide residues such as dieldrin.

In gas chromatography, the water is heated so that some of the substances in it turn to gases. The gases pass through the chromatography machine. They are then analysed to show how quickly they passed through the machine, and how much of each substance was present.

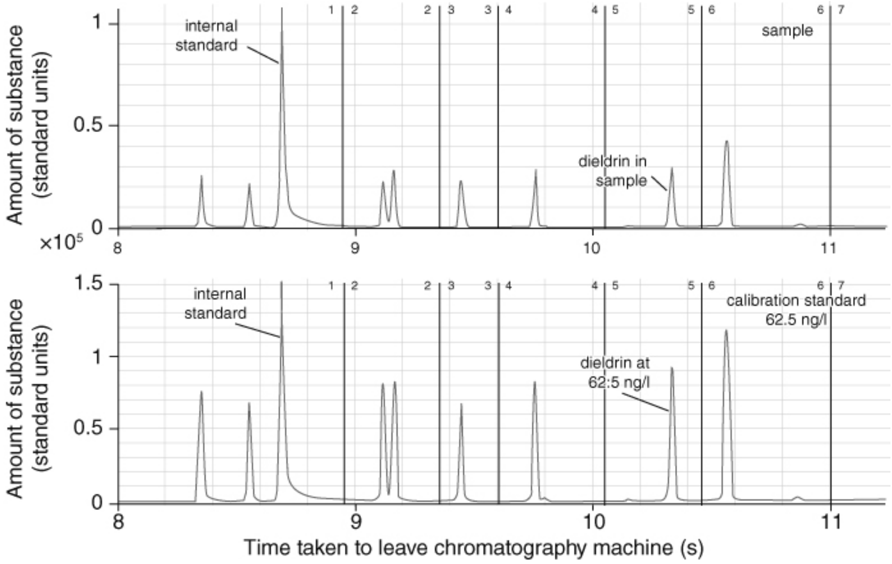
1 What do all methods of chromatography have in common?

2 Why is chromatography needed before the substances can be analysed?

3 Suggest why the substance needs to be analysed after gas or liquid chromatography.

4 Suggest why samples for testing are taken both where the water is released after treatment and from taps in houses.

The diagram shows two graphs produced after gas chromatography. Each peak is a different substance. The peak for the pesticide residue dieldrin has been marked.



Both graphs include an 'internal standard'. This is a fixed amount of a substance that is never found in drinking water. The lower graph was produced using a fixed amount of dieldrin. The upper graph was produced using the same machine, using a water sample.

5 Suggest why the internal standard uses a substance that is never found in water.

6 Suggest why a sample with a known amount of dieldrin is analysed.

7 The UK maximum acceptable limit for dieldrin in drinking water is 0.03 micrograms per dm^3. The known amount of dieldrin was 62.5 nanograms per dm^3 (1000 nanograms = 1 microgram). Was the amount of dieldrin in the unknown water sample within safe limits? Explain your reasoning.

I can…

- analyse a chromatogram and explain how chromatography is used.

Distillation apparatus

Name ______________________________ Class ____________ Date ____________

I can…

- explain how distillation can be used to separate a solvent from a solution.

The diagram below shows the apparatus used to distil a liquid from a solution.

beaker	flask	heat water in	Liebig condenser water out	thermometer

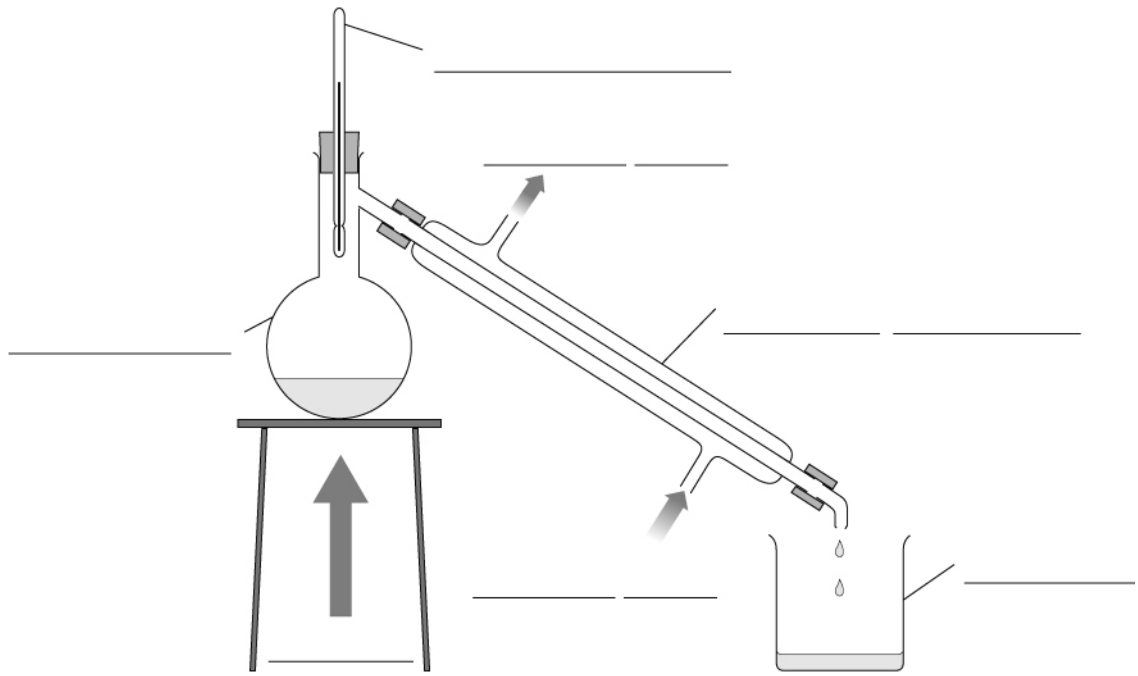
1 Label the parts of the apparatus using words from the box above.

Cut out the labelled diagram and stick it in your book.

2 **a** Put an E on the diagram to show where evaporation takes place.

b Put a C on the diagram to show where condensation takes place.

3 Cut out the boxes at the bottom of the page. Arrange them in the right order to explain what happens when you distil dirty water.



The water evaporates and forms steam. The dirt does not evaporate.	The dirty water mixture is put into the flask.
The mixture is heated.	The steam goes into the condenser.
The water runs into the beaker.	The steam condenses to form pure water.
The cold water flowing around the outside of the condenser cools the steam.	

Building a solar still

Name ______________________________ Class ____________ Date _____________

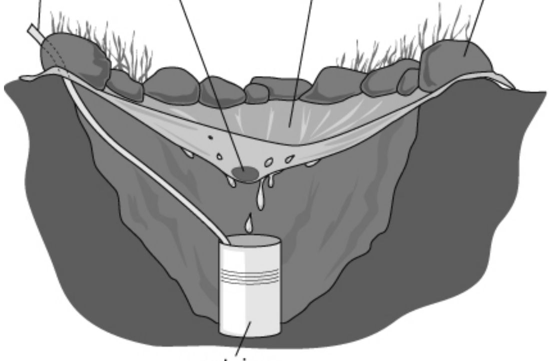
I can…

- describe how a solar still works
- identify factors that may affect the rate of evaporation of water in a solar still.

The diagram shows a design for a simple solar still that could be used to supply emergency drinking water in a place where there is no fresh water.

The air in the hole is heated by the Sun. The heat causes moisture in the soil and air below the sheet to evaporate. As long as the sheet is cooler than the air in the hole, the water vapour will condense on the underside of the sheet and liquid water will run off into the container.

Remember that water evaporates faster as temperature increases, and condenses faster as temperature decreases.



This basic design is not very effective.

1 How could the design be improved to make it as effective as possible?

2 Explain why your changes should increase the amount of water collected.

1 The greater the difference in temperature between the evaporating surface and the cooling surface, the faster water will collect in the container. What needs to be hotter, and what needs to be cooler, to make the still as effective as possible?	**2** Dark objects absorb and give out heat energy faster than light objects. Using dark objects could change temperatures in the still. How could you do this, and how would it be useful?
3 Things in the shade are usually cooler than things in full sunlight. How could this be used in the still to change the rate of evaporation and condensation?	**4** Some of the heat energy from the Sun is wasted because it heats all the air within the hole, but the hole can be dug in any shape. What shape hole would reduce this problem?
5 Fresh plant material contains a lot of water. Dirty water also contains a lot of water. How could this be useful in the still?	

Name ______________________________ **Class** ____________ **Date** _____________

There are many different problems with supplying clean drinking water in different parts of the world, both now and in the future. Below are some of the problems that need to be considered in different places if we are to supply safe drinking water for everyone.

The problem in poor rural areas

83% of the global human population who do not have access to a clean water source live in rural (countryside) areas. Most of them live in very poor countries, where people cannot afford to drill deep wells. Others live in war zones, where people move to temporary camps to avoid the fighting. People (often women and children) may walk miles each day to collect water from the best pools, streams and rivers, but even these may be polluted with disease-causing organisms.

The problem in rapidly growing cities in developing countries

In Africa and South Asia, only about one-third of the people live in cities today. However, as more people move to cities to find work, it is estimated that within 20 years the majority of people will live in cities in these areas. The cities are growing so rapidly that much of the housing consists of poor slum dwellings that have no piped water or sewage. This greatly increases the risk of disease as people drink water polluted by disease-causing organisms.

The problem of an increasing human population and industrialisation

As the human population grows, we not only need more water for us to drink, but also more clean fresh water for animals and for growing crops. Some areas of rapid population growth, such as India and parts of Africa, are also some of the poorest parts of the world. Many industries, including electricity generation, use large amounts of water. So, in countries that are quickly becoming more industrial, such as China and India, the need for water is also growing rapidly.

The problem of climate change

Between September 2010 and March 2012, many parts of England experienced the driest 18 months for over 100 years. This was followed by the wettest April to September on record, which resulted in many people's homes being flooded. If the dry weather had continued, the south and east of England could have suffered severe drought. Extremes of water shortage and rainfall like this are expected to become more frequent as climate changes. This means even places with safe water supplies at the moment need to prepare for problems in the future.

You will carry out research on one of these problems. You should try to answer these questions:

- What is the problem now?
- How is the problem likely to change over the next 50 years?
- How can the problem be tackled?

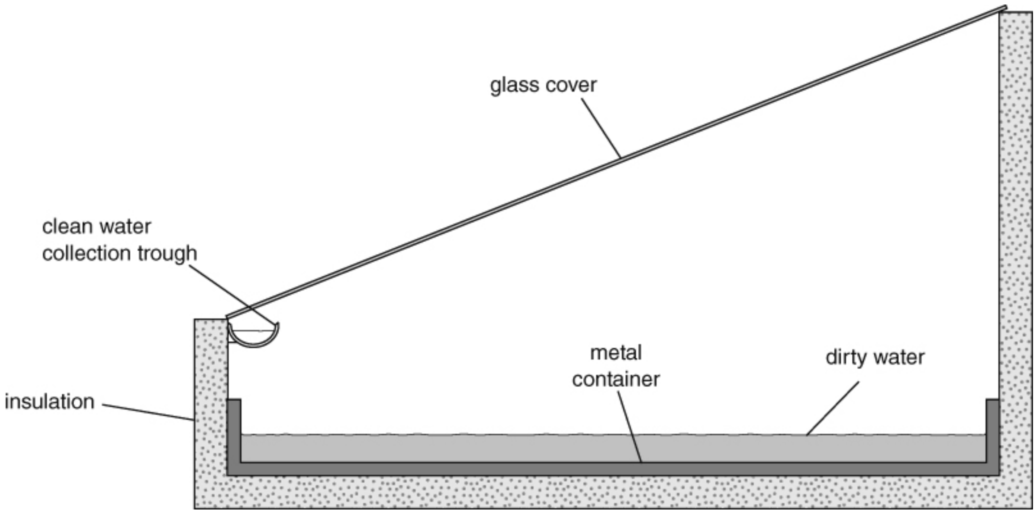
Your teacher will explain what you will do with your findings.

I can…

- identify different problems in the supply of clean drinking water
- suggest solutions for a range of problems in the supply of clean drinking water.

Name ______________________________ **Class** ____________ **Date** _____________

The diagram shows a section through a simple solar still.



1 Complete these sentences using words from the box to explain how the still works.

condenses	evaporates	heats	runs down

a Sunlight passes through the glass cover and ________________________ the dirty water.

b Water ________________________ to form water vapour.

c Water vapour ________________________ on the underside of the cover.

d Water ______________________ into the collection trough and is piped into a container.

2 Which process is taking place inside the solar still? Circle *one* word.

desalination   distillation   insulation   concentration

3 Choose the sentence that best explains why the solar still has an insulated base.

☐ It helps to produce cleaner water.

☐ It helps to prevent damage to the metal container.

☐ It helps the dirty water to stay warmer for longer so more water evaporates.

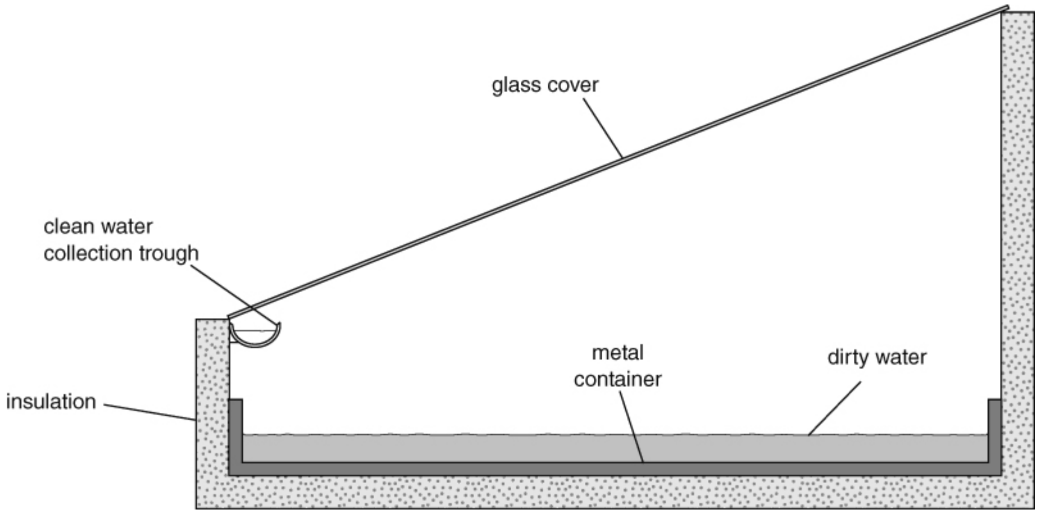
☐ It helps the dirty water to stay cooler so that more water vapour condenses.

I can…

- describe how a solar still works
- explain features of a solar still that affect how it works.

Name ______________________ **Class** __________ **Date** __________

The diagram shows a section through a simple solar still.



1 Describe as fully as you can how the solar still produces clean water from dirty water.

____

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2 The process taking place in the still is distillation. Explain what this means.

____

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3 Explain why insulating the base of the still increases the amount of clean water collected.

____

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____

4 Describe one other improvement that could be made to the still so that it produced more water. Explain your answer.

____

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____

____

I can…

- describe how a solar still works
- explain features of a solar still that affect how it works.

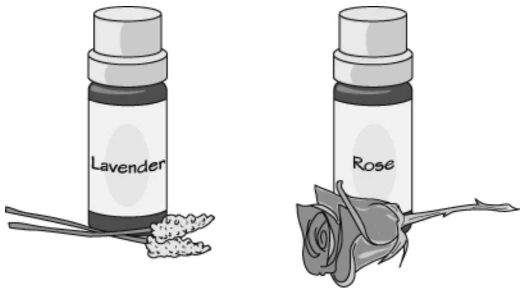
Name ______________________________ Class ____________ Date _____________

Perfumes contain aromatic (smelly) substances that have been extracted from plant material. The extraction method used depends on the plant and the aromatic substances that are produced.

Woody and amber fragrances are extracted by heating the chopped plant material directly, in a process called dry distillation. This heating creates a slightly 'burned' smell, which is important for the fragrance. The aromatic substances evaporate in the heat and are then cooled to form a liquid.

Essential oils, such as lavender and peppermint, are extracted by steam distillation. Water is heated in a separate flask to produce steam. The steam passes through the chopped plant material, heating it up so the aromatic substances evaporate. The vapour of steam and aromatic substances are then cooled. This forms a mixture of water and oils, which are collected in a flask. As oil and water don't mix easily they form separate layers, so the essential oil can easily be removed. Small amounts of the aromatic substances remain in the water, and this mixture may be sold as eau de cologne.

Some delicate aromatic substances, such as rose and jasmine, are easily spoilt by heat. So they are extracted by mixing the plant material with a solvent. The solvent is removed to leave a wax that contains the fragrant oils and other substances. The wax is mixed with ethanol, which dissolves the fragrant oils. The alcohol/oil mixture is then distilled to separate out the oil, which is now called an absolute.



1 All perfumes are volatile (evaporate easily). Explain why this is essential to their use.

2 Sketch a labelled diagram or flowchart to describe the process of steam distillation, using collected plant material such as lavender. Remember to use any suitable science words in your labels.

3 Compare your diagram or flowchart from Q2 with the description of dry distillation.

- **a** How do the processes of dry distillation and steam distillation differ?
- **b** Suggest how the differences limit which fragrant oils are extracted by dry distillation.

4 Ethanol has a boiling point of about 78 °C. Explain the importance of this in the preparation of absolutes from rose and jasmine for the perfume industry.

5 It is almost impossible to separate completely ethanol and water using distillation. The best conditions produce a mixture of around 95.6% ethanol and 4.4% water.

- **a** Use your knowledge of the boiling points of water and ethanol to suggest the conditions used to produce this mixture. Explain your answer.
- **b** Explain why it is not possible to separate these substances completely using distillation.

I can…

- explain how distillation works in an unfamiliar situation.