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Diffusion

1:03 understand how the results of experiments involving the dilution of coloured solutions and diffusio gases can be explained

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Diffusion

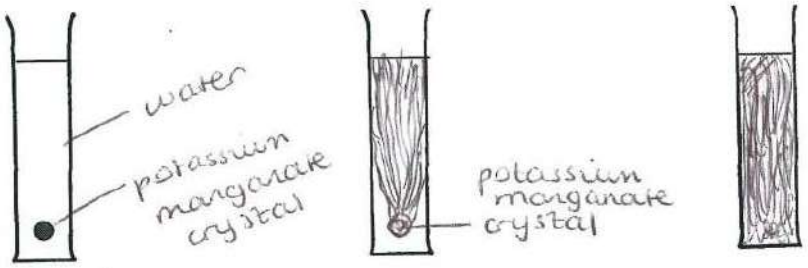
Diffusion is the net movement of particles from areas of high concentration to areas of low concentration u uniform concentration is achieved.

It is brought about by the random movement of particles and it takes place independently of gravity.

Diffusion demonstration 1

By means of a thin glass tube a crystal of potassium manganate(VII) is introduced into the bottom of a larg measuring cylinder full of water.

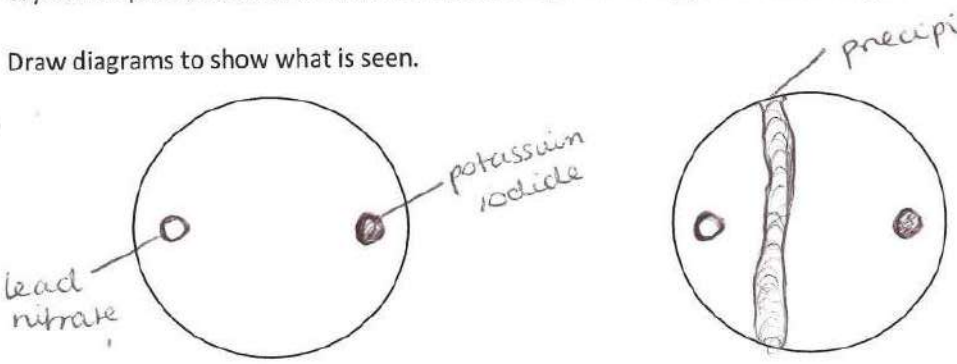
Draw diagrams to show what is seen.



Diffusion demonstration 2

Crystals of potassium iodide and lead nitrate are placed at opposite ends of a petri dish containing water.

Draw diagrams to show what is seen.



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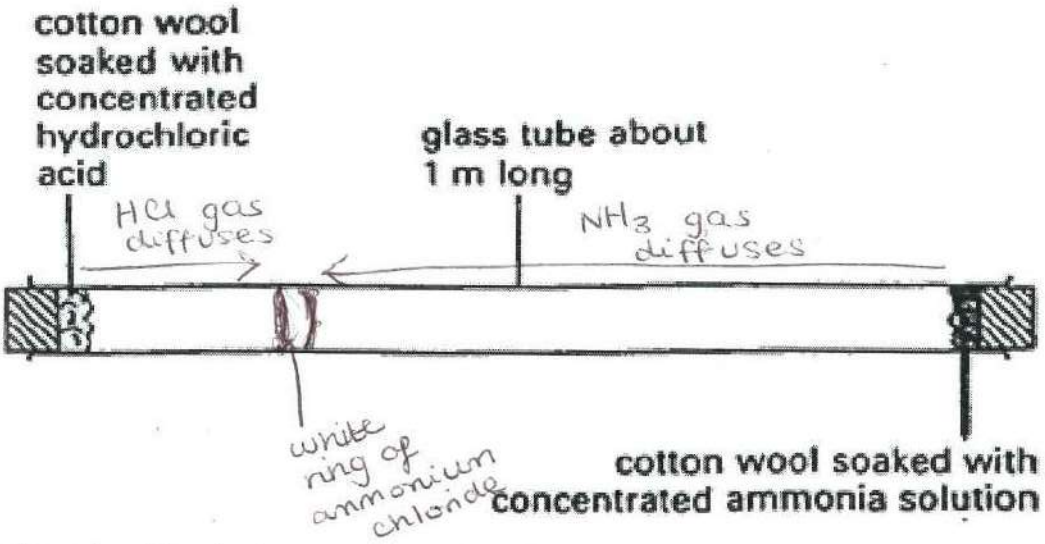
Diffusion demonstration 3

A long tube has cotton wool soaked in concentrated hydrochloric acid (HCl) inserted in one end and cotton wool soaked in concentrated ammonia (NH_3) inserted in the other.



Describe and explain what happens in terms of particles.

~~an powerpoint~~

- particles of NH_3 diffuse towards HCl.
- particles of HCl diffuse towards NH_3
- HCl and NH_3 particles collide with each other to form ammonium chloride.

Where in the tube does the reaction take place? Explain this.

~~an powerpoint~~

- reaction takes place closer to HCl since this is where white ring forms
- ammonia particles travel further than HCl particles (in the same time)

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Solubility

Learning outcomes:

- Be able to define the terms: solvent, solute, solution, saturated solution
- Be able to state and explain that solubility is given in in the units g per 100 g of solvent

This topic is all about separating substances which are mixed together.

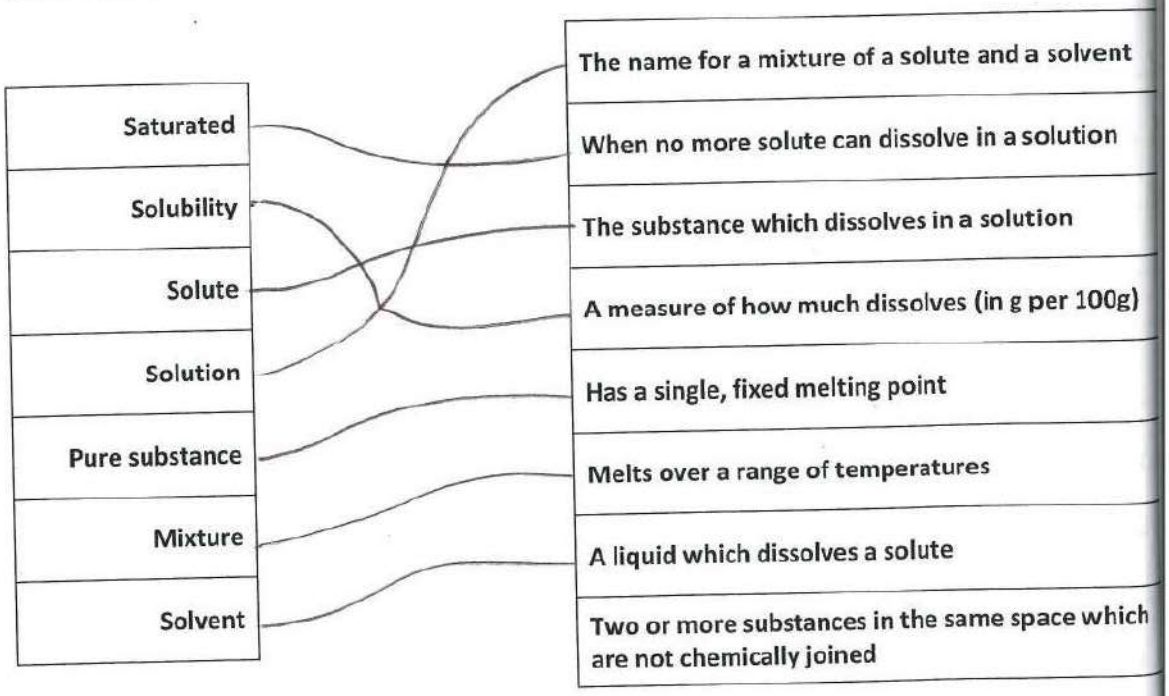
To understand how to separate mixtures, it is important to understand solubility.

The maximum number of grams of any solid which will dissolve in 100g of solvent at a given temperature called the solubility of that solid at that temperature.

A solution which has as much solute dissolved in it as is possible is called a saturated solution.

Dissolving is a physical change, not a chemical change. The solute and solvent just mix together to form a solution, they do not change into different substances. The process of dissolving is easily reversed.

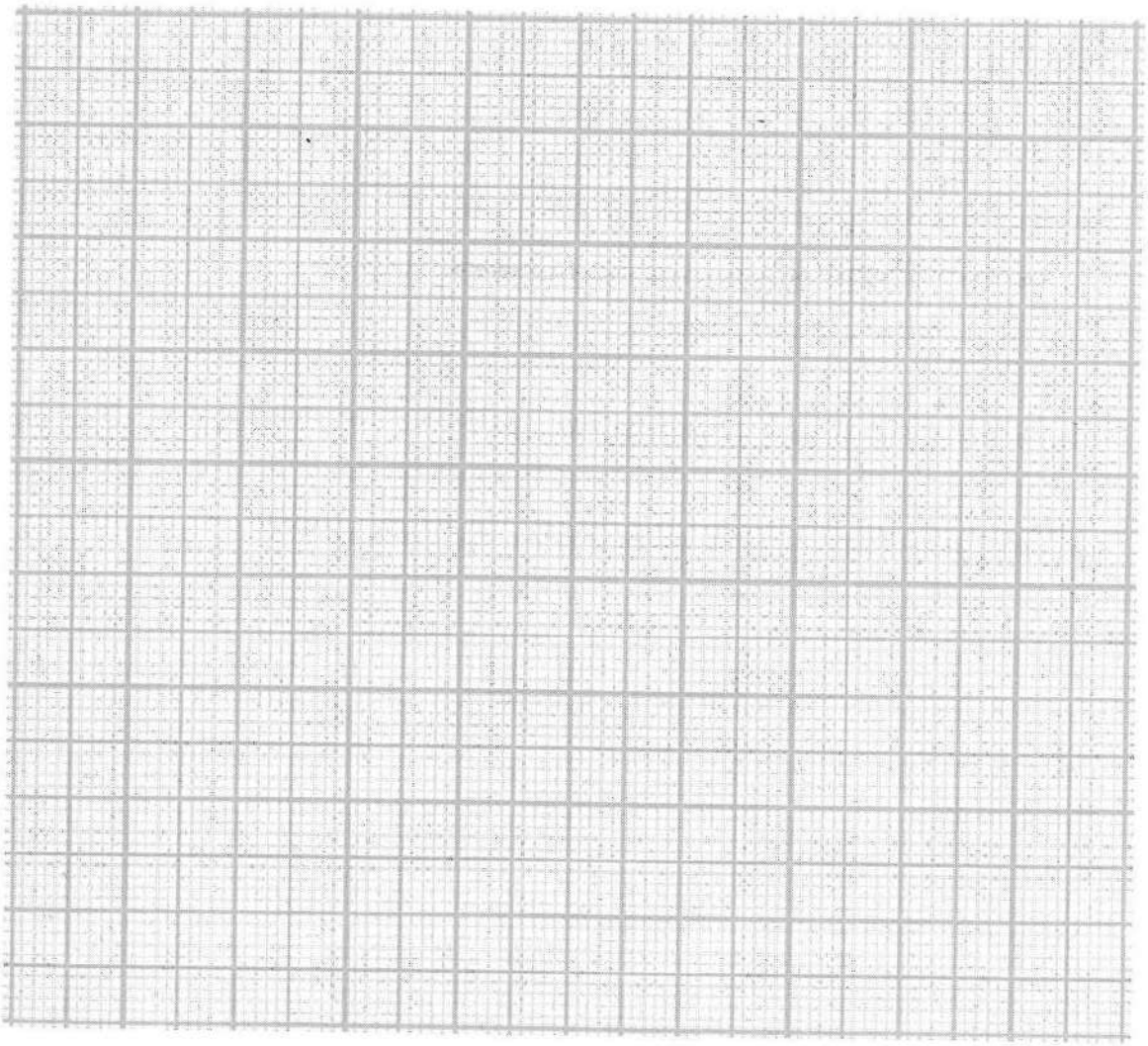
Task: match up the terms and sentences in the two columns



Demo: how much salt can dissolve in water?

A pupil measured the mass of sodium chloride that dissolved in different volumes of water.

Volume of water (cm^3)	Mass of sodium chloride which just dissolves (g)	Solubility (g/100g)
0	0	0
75	25	33.3
160	58	36.3
240	80	33.3
380	140	36.8
475	170	35.8



Solubility is the maximum mass (in grams) of a solute which can dissolve in 100g of a solvent.

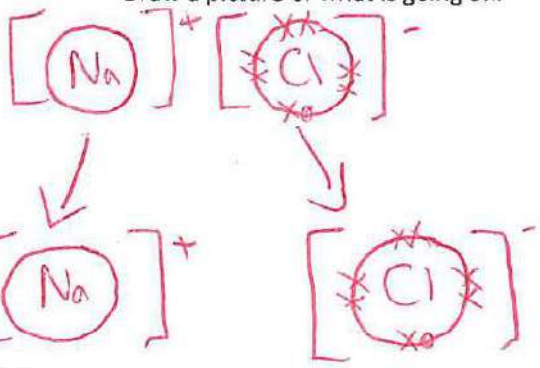
Calculate the solubility of sodium chloride in water.

How did the volume of the saturated solution compare to the volume of solvent?

Does this seem strange and how could it be explained?

Volume remains the same. Sodium Chloride dissociates into its ions and can 'hide' among the water molecules so overall volume of solution doesn't change, as ions are very small and compact.

Draw a picture of what is going on.



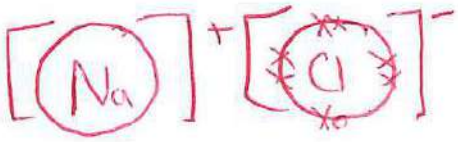
How could we change the experiment to increase the solubility?

Increase the temperature.

What *type* of bonding is present in solid sodium chloride?

Ionic bonding.

Draw a dot and cross diagram to show the bonding in sodium chloride.



List the four state symbols and next to each write its meaning.

(s) solid

(l) liquid

(g) gas

(aq) aqueous → in solution

When a substance dissolves:

solute + solvent → solution

Although the addition of sodium chloride to water is a physical change (not a chemical change), what equations can be written to show what is going on?

Word equation:

salt + water → salty water

What is the chemical equation?

~~NaCl + H_2O → NaCl.H_2O~~

$NaCl(s) + H_2O(l) \rightarrow NaCl(aq)$

Demonstration

Whether some solute dissolves depends on which solvent is used.

Some substances that are soluble in water do not dissolve in other liquids.

Some substances that are insoluble in water do dissolve in other liquids.

salol / nail varnish in water / acetone.

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Solubility Curves

The mass (g) of a solute that will dissolve in a solvent depends on the temperature.

The solubility of potassium nitrate in water changes as follows:

Temperature (°C)	Solubility (g per 100g water)
0	12
10	20
20	30
30	44
40	60
50	80
60	104
70	131

1) Plot the **solubility curve** to show the solubility of potassium nitrate (vertical axis) against temperatu (horizontal axis). Then use your graph to answer the following questions.

2) What is the relationship between the temperature of water and the solubility of potassium nitrate?

As temperature increases, solubility of KNO_3 also increases.

3) What is the solubility of potassium nitrate at

a) 27°C? 40 g / 100 g water

b) 55°C? 92 g / 100 g water

4) At what temperature can 70g of potassium nitrate dissolve in 100g of water?

read across @ 70 g solubility ⇒ 45°C

5)

a) 110g of potassium nitrate was added to 100g of water in a beaker and the water was heated. Assuming that no water evaporates, at what temperature does the potassium nitrate just diss

around 63°C

b) The solution in a is cooled to 18°C. What mass of crystals forms at the bottom of the beaker?

28 g @ 18°C = 110 − 28 = 82 g

6) How many grams of potassium nitrate are required to make a saturated solution in 200g of water a 50°C?

80 g / 100 g water @ 50°C

∴ in 200 g water = 80 × 2 = 160 g

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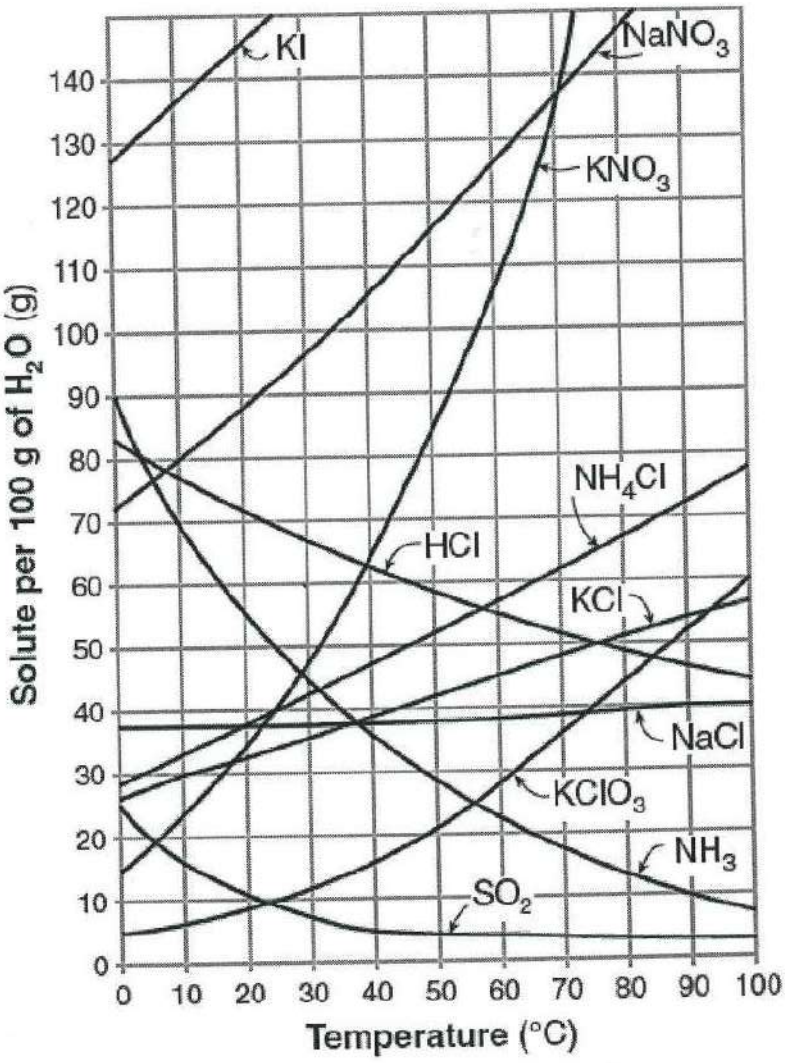
Questions on Solubility Curves

The graph shows the solubility of a number of different salts in water

Table G Solubility Curves



1. If 50g of water saturated with ammonium chloride (NH_4Cl) at 40°C is slowly evaporated to dryness, how many grams of dry salt will be recovered?

47 g of NH_4Cl @ 40°C (100g H_2O)

∴ 50g of H_2O = $\frac{47}{2}$ = 23.5 g

2. What is the smallest mass of water required to completely dissolve 7 grams of ammonium chloride (NH_4Cl) at 85°C?

70 g NH_4Cl @ 85°C (100g H_2O)

to dissolve 7g $\frac{100}{10}$ = 10g

3. A saturated solution of sodium nitrate ($NaNO_3$) in 100g of water at 40°C is heated to 50°C. How much more solid can be dissolved?

105 g – 115 g
∴ 115 – 105 = 10g more

4. Which salt has solubility values that are least affected by temperature?

NaCl – very small increase on graph

5. If 30g of potassium chloride (KCl) is dissolved in 100g of water at 45°C, how many additional grams would be needed to make the solution saturated at 80°C?

30 g – 45°C
51 g – 80°C
51 – 30 = 21 g

6. At what temperature do potassium chloride (KCl) and potassium nitrate (KNO_3) have the same solubility in water?

17°C

7. At 25°C, 100g of water is saturated with potassium nitrate(KNO_3). How many grams of solid will precipitate out of solution when it cools to 0°C?

40 g @ 25°C
15 g @ 0°C
∴ 40 – 15 = 25g

8. How many grams of sodium chloride(NaCl) are required to saturate 500g of water at 100°C?

40 g @ 100°C (100g H_2O)
@ 500 g H_2O = 40 × 5 = 200 g NaCl

9. Which compound is least soluble in water at 12°C?

$KClO_3$

10. Which compound is most soluble in water at 50°C?

~~$NaNO_3$~~ KI

11. How many grams of sodium nitrate ($NaNO_3$) are required to saturate 200g of water at 10°C?

80 g @ 10°C (100g H_2O)
for 200g H_2O = 80 × 2 = 160g $NaNO_3$

Distillation

Learning outcomes:

- Describe distillation as a technique for the separation of certain mixtures
- Explain that a pure substance has a fixed melting and boiling point, but that a mixture may melt or boil over a range of temperatures
- Explain a physical test to show whether a sample of water is pure

Distillation is a combination of two processes; evaporation and condensation.

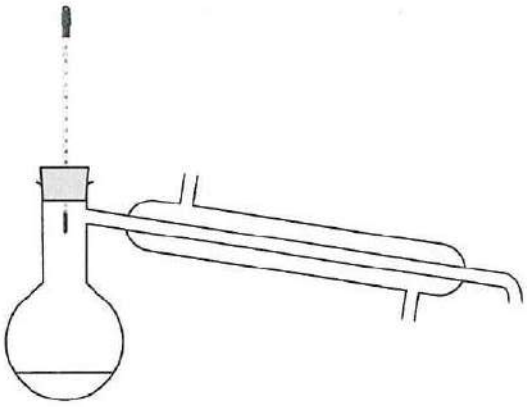
Making a solar still to distil sea water.

Whether to use simple distillation or fractional distillation depends on what types of substances are mixed:

Simple distillation is used to separate a liquid from a mixture.

It is a mixture of 2 processes:
Evaporation and Condensation.

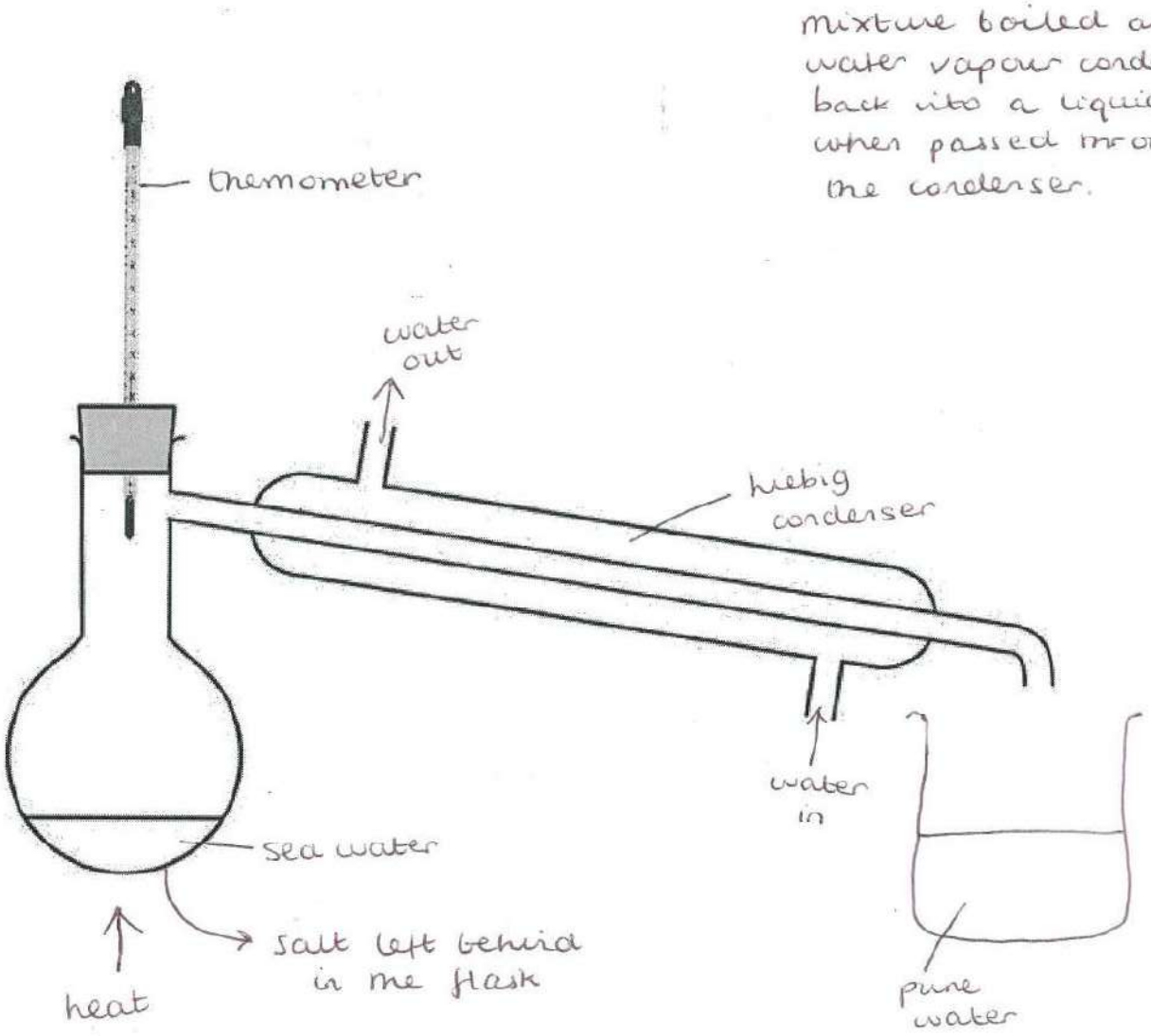
For example, drinking water can be obtained by distillation of seawater. This uses a lot of energy and so it is only used when there is very little fresh water and there is a cheap supply of energy e.g. in the Middle East.



Simple distillation

Simple distillation is use to obtain pure water from a mixture of salt and water

Watch the demonstration and label the diagram. Add notes to explain fully the process.



The flask must not be more than one third full, or else it might boil over and down into the condenser.

The anti-bumping granules make sure that it boils smoothly.

The thermometer will give the boiling point of the liquid that is being distilled, i.e. in this case 100°C

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Questions on simple distillation

1) Explain why water enters at the lower end of the Liebig condenser and leaves at the top?

If water enters from the bottom of condenser, the condenser will be completely filled with cold water to condense gas to liquid.

2) Explain why the distillation flask should not be more than one third full.

To allow the liquid particles to have enough space to expand as liquid is heated to become a gas. Otherwise, liquid boils over and down into the condenser.

3) Explain what temperature the thermometer reads during distillation.

Thermometer gives boiling point of the liquid that is being distilled.

4) State the chemical test for the presence of water.

Add anhydrous copper sulfate. Colour change from ~~pale blue~~ white to ~~bright~~ blue if water present.

5) State the physical test for the purity of water.

Heat the sample and measure the temp. If sample is pure water, it will boil at 100°C.

6) Drinking water can be produced from sea water by simple distillation.
Explain why this done in some parts of the Middle East but is not done in Great Britain?

Uses a lot of energy and so is only done when there is very little fresh water available and a cheap supply of energy eg. in the Middle East.

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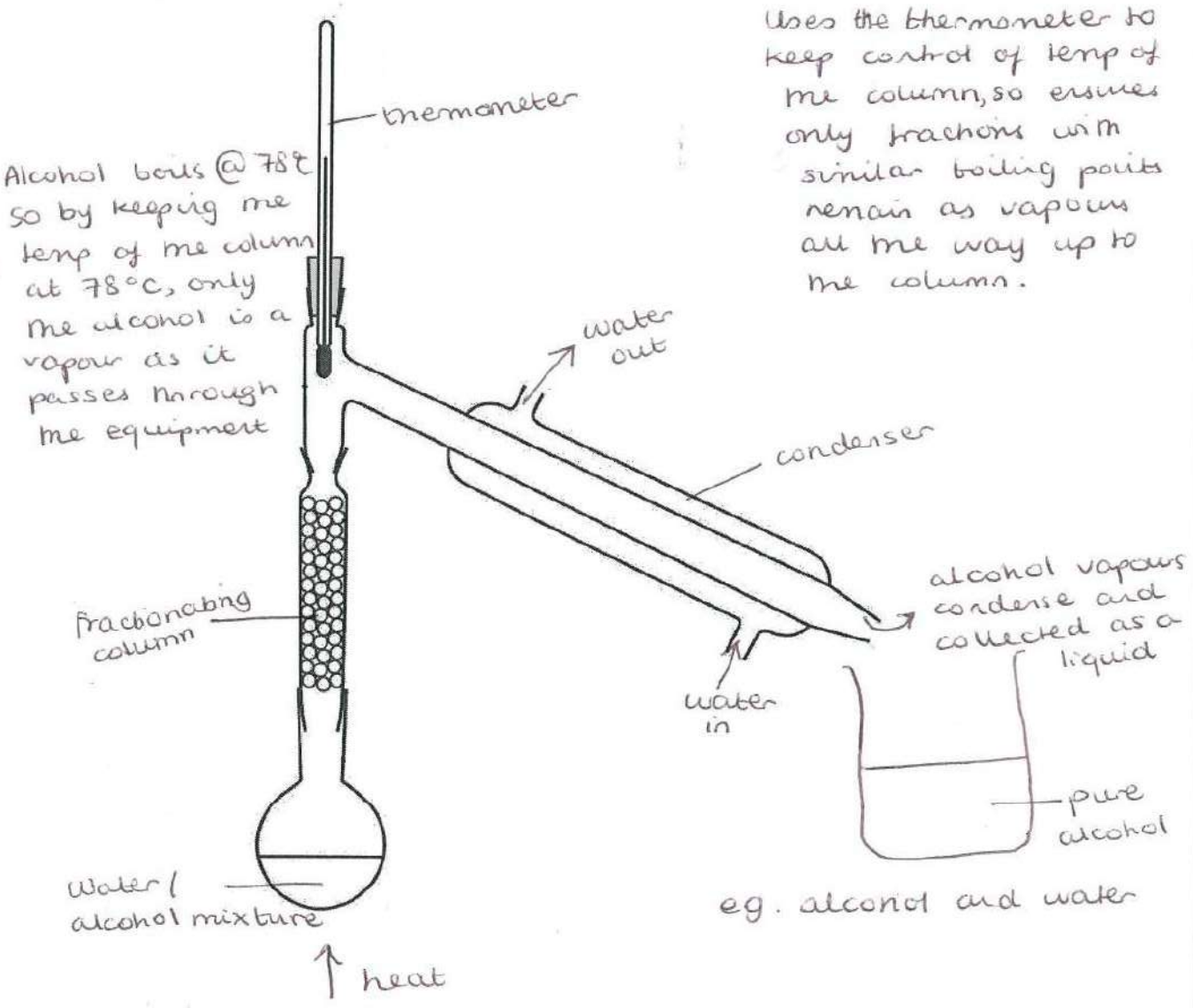
Fractional Distillation

Fractional distillation is used to separate two or more miscible liquids with different boiling points.

Label the diagram. Add notes to explain fully the process:



If there are many liquids present it may not be possible to separate them completely. Instead they are separated into fractions (liquids with similar boiling points) e.g. a fraction with boiling points between 35 and 45°C

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When would you use fractional distillation rather than simple distillation? In your answer, start by describing clearly the purpose of each process.

- Simple distillation is used to separate the liquid from a solution eg. water from salt water.
- Fractional distillation is used to separate a mixture of different liquids which have different boiling points eg. separating alcohol from a mixture of alcohol and water
- Fractional distillation should be used if there are multiple (two or more) miscible liquids present with different boiling points.

Example: Production of alcohol

Sugars can be broken down in the presence of yeast to give ethanol (an alcohol) and carbon dioxide in a prc called fermentation. As yeast is killed by concentrated alcohol, this method can only produce drinks contain up to 14% alcohol, eg wine.

Spirits (drinks with around 40% alcohol concentration) can then be produced.

Different countries produce different spirits using different sources of sugar:

Country	Spirit	Source of Sugar
Scotland	Whisky	Barley
France	Brandy	Grapes
West Indies	Rum	Molasses (sugar cane)
Russia	Vodka	Corn or potatoes
Mexico	Tequila	Cactus

How can wine be turned into spirits?

- Distillation of the mixture of alcohol and water by fractional distillation will cause alcohol to become a vapour at 78°C and collected as a liquid.
- The alcohol is then pure and has a higher alcohol concentration.

Example: Fractional distillation of crude oil

Crude oil is a mixture of hydrocarbons (compounds of hydrogen and carbon only) and there are a very large number of possible compounds e.g. methane (CH_4) and propane (C_3H_8). The smaller the molecule the lower its boiling point tends to be, so they can be sorted into fractions by distillation and then used for lots of different purposes.

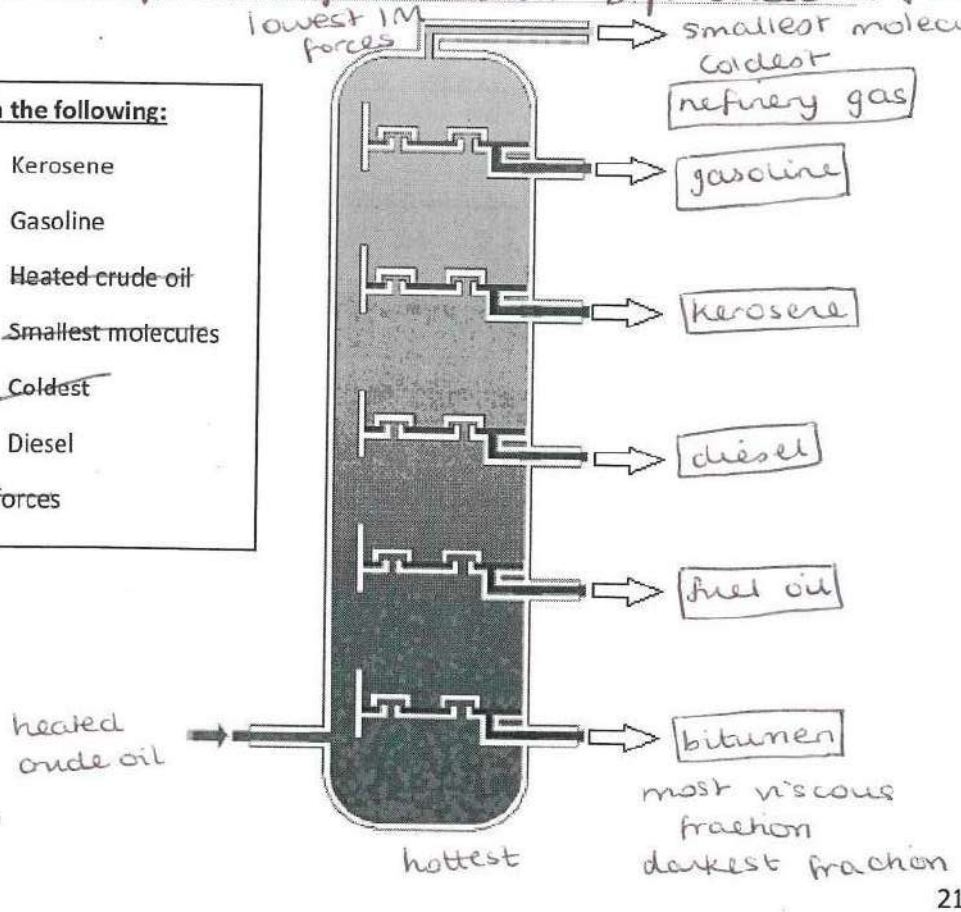
Fraction	Boiling range (°C)	Uses
Refinery gas	below 25	fuel e.g. camping gas
Petrol/gasoline	40 - 100	fuel for cars
Kerosene	150 - 240	aircraft fuel
Diesel oil	220 - 250	fuel for lorries etc.
Fuel Oil	300 - 350	fuel for ships, central heating
Bitumen	above 350	road-making

Explain the process of the fractional distillation of crude oil

- Heated crude oil enters a fractionating column
- Different fractions are collected at different temperatures and these fractions are separated by boiling point.
- The fraction vapours cool and condense as they exit the tower, with the fraction of the lowest b.p. collected first.

Label the diagram with the following:

Fuel oil	Kerosene
~~Darkest fraction~~	Gasoline
~~Bitumen~~	~~Heated crude oil~~
Refinery gas	~~Smallest molecules~~
~~Most viscous fraction~~	~~Coldest~~
~~Hottest~~	Diesel
~~Lowest intermolecular forces~~	

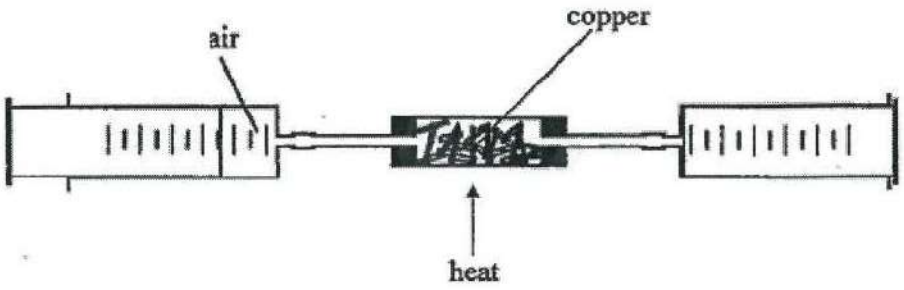


Composition of Air

Learning Outcomes:

1. Recall the approximate percentages by volume of the four most abundant gases in dry air
2. Explain how to determine the percentage by volume of oxygen in air using experiments involving the reaction metals (e.g. iron) and non-metals (e.g. phosphorus) with air

Practical: Investigating the % of oxygen in air



- Dry air is passed over hot copper from one syringe to the other until there is no further change in volume
- Volume of gas decreases since oxygen removed from air as it reacts with the copper

Results

The copper turns black, forming copper oxide.

The initial volume of air in the syringe: 100 cm^3.

The final volume of gas in the syringe: 79 cm^3.

Conclusion

The original volume of dry air contains: 21 cm^3 oxygen.

Now we want to work out the % of oxygen in dry air:

$$\% \text{ oxygen} = \frac{\text{start vol.} - \text{end vol.}}{\text{start vol.}}$$

Therefore dry air contains 21 % oxygen.

Questions

1. The apparatus was allowed to cool down to room temperature before reading the final volume of gas.

   Explain why.

Gases expand (become less dense) when heated.

To allow the gas to return to its original density, so the gas can be compared with the starting volume.

★ 2. Explain why copper was used in the tube between the two syringes rather than magnesium.

Magnesium would react with not only oxygen in the air. Mg can also react with nitrogen at high temperatures to make magnesium nitride.

3. Explain whether it matters how full the tube is with copper. Think what would happen if only a very little copper was used or if lots of copper was used.

Copper should be in excess to ensure all of the oxygen has reacted.

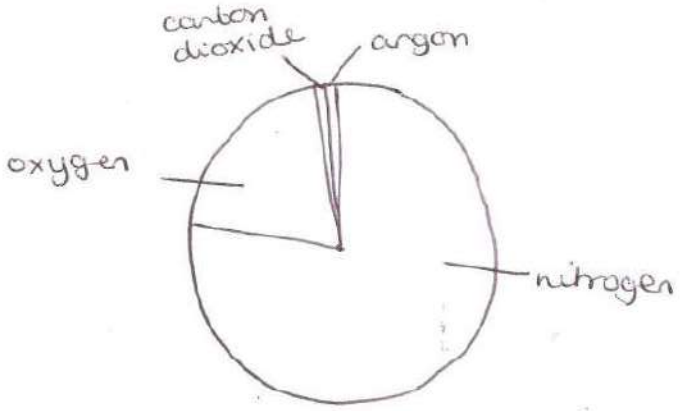
4. Write the word equation for the reaction of copper with oxygen.

copper + oxygen → copper oxide

5. If the tube containing the copper was weighed before and after the experiment, would you expect the mass to change? Explain your answer.

Mass increases, as now the mass of oxygen would cause one increase as copper oxide is produced.

1. The other main gases in dry air are nitrogen (78.%), argon (0.9%) and carbon dioxide (0.04%). Draw a pi chart to show the composition of air.



2. What is meant by "dry air"?

Dry air is air without water vapour.

Example: Fractional distillation of air

The different parts of air have different boiling points:

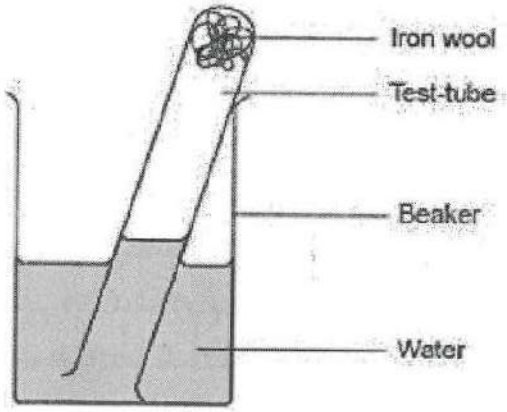
Element (and abundance in air)	Boiling point (°C)
argon (1%)	-186
neon	-246
nitrogen (78%)	-196
oxygen (21%)	-183

If air is cooled and compressed it will all eventually become a liquid. The different parts of air can then be separated by fractional distillation. Explain which element will be collected first.

Neon is collected first as neon has the lowest boiling point and fraction with the lower boiling points exit the fractionating column and are collected first.

Other reactions to determine the % abundance of oxygen in the composition of air

Iron rusting



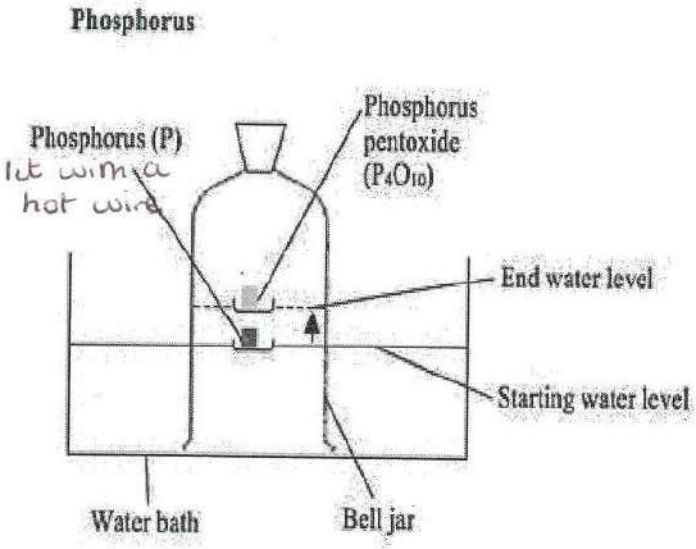
reacts with oxygen in the air.

iron + oxygen + water → rust

↓

hydrated iron (III) oxide

Burning phosphorous



phosphorus reacts with oxygen in air and causes water level in bell jar to rise by ~20%.

phosphorus + oxygen → phosphorus oxide

Preparation of Hydrated Copper (II) Sulfate Crystals, $CuSO_4.5H_2O$

A base is a metal oxide, eg magnesium oxide. Can you name some more bases?

copper oxide
sodium oxide

Here are two key reactions involving acid:

acid + alkali → salt + water (AAWS)

acid + base → salt + water (BAWS)

These reactions are both called neutralisation reactions.

Some bases dissolve in water to form soluble metal hydroxides. Soluble bases are called alkalis.

soluble base + water → soluble metal hydroxide

alkali

In the production of hydrated copper sulfate crystals, the following reaction can be used:

BAWS

copper (II) oxide + sulfuric acid → (copper sulfate + water / hydrated copper sulfate)

$$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$$

Neutralisation

Evaluating preparation of $CuSO_4$

Learning outcomes:

- Be able to explain the steps involved in preparation of $CuSO_4$
- Evaluate the preparation of $CuSO_4$

To understand properly why the process of making copper sulfate crystals involves adding an *excess* of co oxide, it is useful to think of the contents of the beaker at different points during the neutralisation reacti stage.

1. Why is the acid heated?

   Speeds up rate of reaction

2. When you added the copper oxide to the sulfuric acid, how did you know a reaction had occurred?

   A colour change occurs from black to blue.

3. Why was it important to ensure the copper oxide was added in excess?

   To neutralise all of the acid

4. How did you get rid of the excess solid (the excess copper oxide)?

   Filter mixture using filter paper and funnel

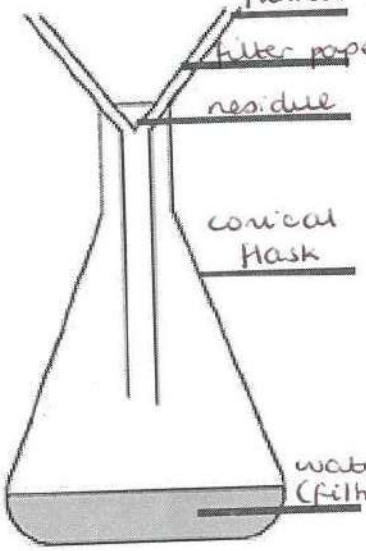
5. How will you get the salt out of the solution?

   - Allow solution to cool as copper sulfate is less soluble in cold water.
   - Remove crystals by filtration and wash with distilled water to remove impurities
   - Dry to evaporate water, leaving crystals of salt

Filtration

The purpose of filtration is to separate insoluble solutes from solvents

With reference to particles, explain how filtration works eg. sand and water

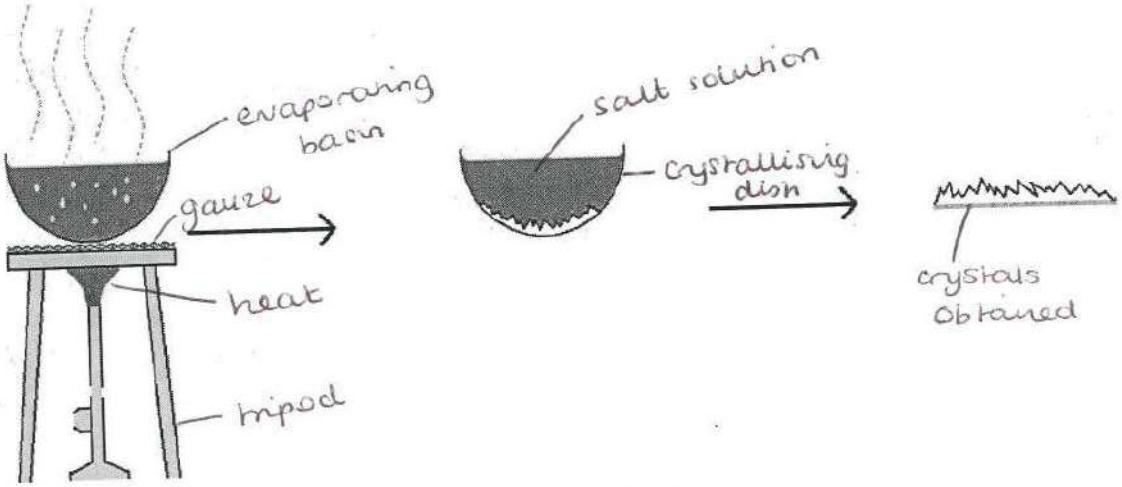


- mixture is poured into the filter paper
- Sand particles are too large and do not pass through and is left behind (residue)
- Water particles are small enough to pass through gaps in the filter paper and is collected in the conical flask (filtrate).

Crystallisation

The purpose of crystallisation is to separate ~~soluble~~ ~~solvents~~ salt from salt solution

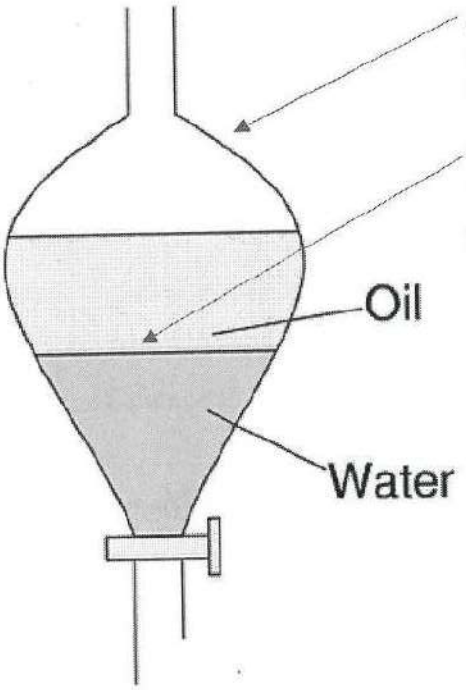
to obtain the crystals of salt



Annotate the diagram to describe the process of crystallisation

Separating a mixture of immiscible liquids

If two liquids are immiscible then they will form separate layers, with the less dense layer on top.



A separating funnel is used. When the tap is open, the bottom lay runs out the bottom and can be removed. The top layer is left in th funnel.

At the boundary, it is a good idea to collect the liquid separately as otherwise there might be some contamination.

- Immiscible means the liquids do not dissolve in each other
- eg. oil and water

Paper Chromatography - Method

1) Draw a pencil line 1cm from the bottom of the paper

Why is the line drawn in pencil? Pencil will not dissolve in the solvent but if ink were used, instead it might dissolve and interfere with results of the chromatography

2) Place drops of each sample on the line

3) In pencil record at the top what the sample is

4) Suspend each sample in a solvent of water so only the bottom edge of the paper is in the water

What types of solvent are typically used?

water, ethanol (organic solvent)

Why is it important to keep the pencil line and dots of dyes above the solvent?

Otherwise, all of the ink spots would dissolve in the solvent.

5) Wait until the solvent is near the top and remove your sample and let them dry.

6) Sometimes the solvent used is volatile and flammable. In this case, what are the 2 reasons a lid might be used in the chromatography?

- So the atmosphere becomes saturated with the solvent
- So solvent does not evaporate from surface of the paper

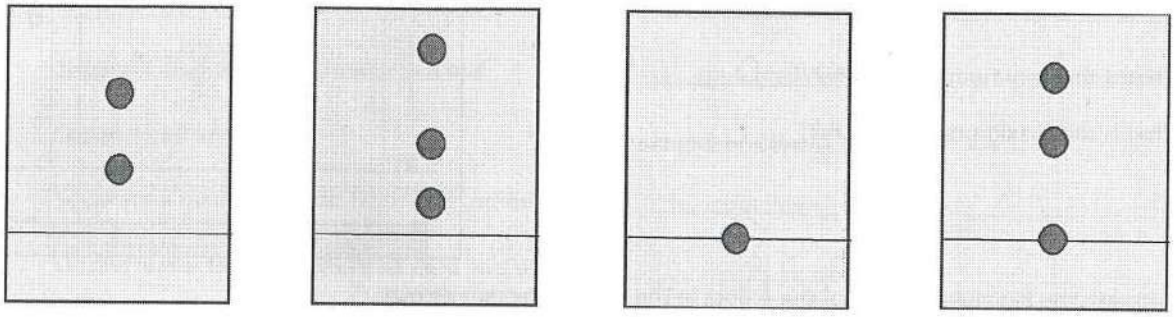
7) Why do you think some colours move further up the paper than others?

Some dyes are more soluble than others and these dyes are carried further up the paper.

8) Why might it be necessary to use different solvents?

Not all solutes and inks (dyes) are soluble in one solvent. The solubility of the dye depends on the solvent.

9)



A B C D

What can you say about the dyes used in each of the chromatograms above? First is done for you.

A A is made of 2 different dyes.

Both of the dyes in A are soluble in the solvent used.

B B is made of 3 different dyes

All three dyes are soluble in solvent used.

C Cannot be sure how many dyes make up C as none of the dyes are soluble in solvent used.

D D is made up of at least 3 different dyes

Two of the dyes are soluble in the solvent used and the rest are not soluble.

Paper chromatography: Calculating Retardation Factors (R_f)

To quantify how soluble each dye is, the R_f value is calculated.

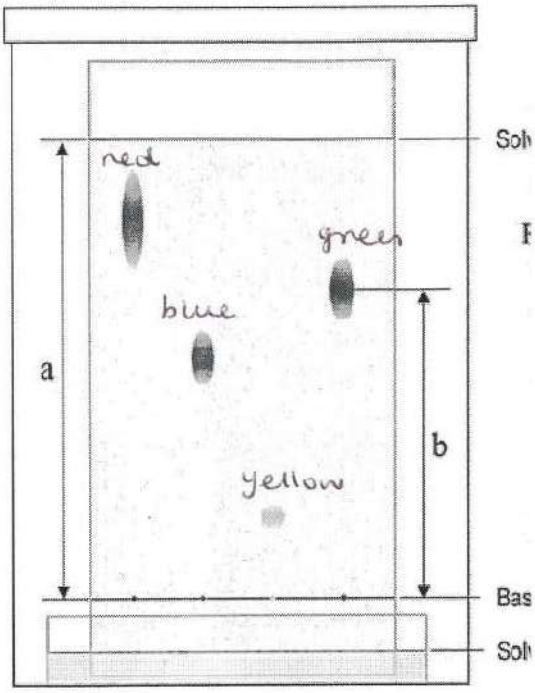
Dyes which are more soluble will travel higher up the paper.

Measure:

a = distance travelled by solvent

b = distance travelled by solute

$$Rf = \frac{distance\ travelled\ by\ solute}{distance\ travelled\ by\ solvent} = \frac{b}{a}$$



What is the minimum value of R_f? 0

What is the maximum value of R_f? 1

Calculate the R_f value for each of the 4 dots in the chromatogram shown:

Green:

Red:

Blue:

Yellow:

Separating Techniques summary questions

State the separating technique you would use to do the following:

Separate the food colourings in a sweet — chromatography

Obtain salt from a solution of salty water — ~~crystallisation~~ evaporation

Separate various parts of crude oil — fractional distillation

Obtain sand from a mixture of sand and water — filtration

Obtain water from a solution of salty water — simple distillation

Separate iron filings and water — filtration

Separate the various pigments in a leaf — chromatography

Separate oil and water — separating funnel

Separate a mixture of inks from each other — chromatography

Obtain water from a mixture of sand and water — filtration

Obtain sugar from a mixture of sugar and water — ~~crystallisation~~ evaporation

Obtain copper sulfate crystals from a copper sulfate solution

crystallisation

How would you separate all the components of a mixture of sand, water, crude oil, various inks, ethanol, salt and a hockey ball?

- Filter to remove hockey ball and sand
- Fractional distillation to remove water from ethanol
- separating funnel to remove crude oil from water
- Simple distillation to remove salt from water
- Chromatography to separate various inks

QUESTIONS AT THE BACK OF THE BOOKLET

1)

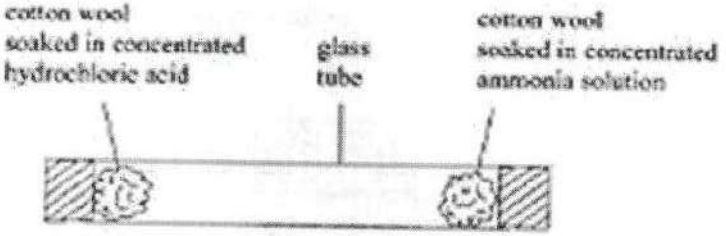
The decomposition of ammonium chloride is a reversible reaction.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

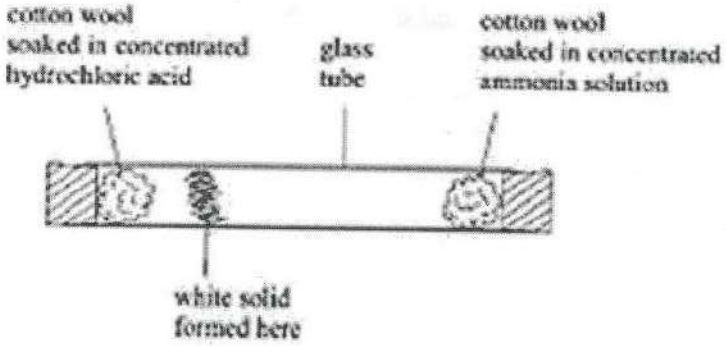
a) what is the meaning of the (s) and (g) in the equation? solid and gas (1)

(b) Concentrated hydrochloric acid gives off hydrogen chloride gas.
Concentrated ammonia solution gives off ammonia gas.

An experiment is set up.



After a few minutes a white solid forms inside the tube. The solid forms when ammonia gas reacts with hydrogen chloride gas.



(i) Name the process by which the ammonia and hydrogen chloride particles move inside the tube.

diffusion

(1)

(ii) What is the white solid that forms inside the tube?

ammonium chloride

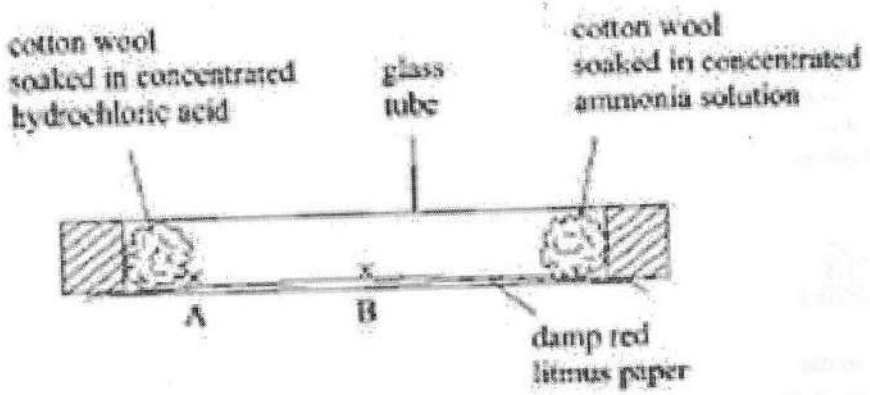
(1)

(iii) What does the position of the white solid tell you about the relative speeds at which the ammonia and hydrogen chloride particles move?

Ammonia particles are moving faster than the hydrochloric acid particles

(1)

(iv) The experiment is repeated with a strip of damp red litmus paper placed along the inside of the tube.



State the colour of the litmus paper at A and B when the white solid forms.

A red

B blue

(2)

(a) A warm saturated solution of potassium nitrate contained 140 g potassium nitrate in 200 cm^3 water.

(i) Identify the solute and solvent in this solution.

Solute ....potassium nitrate....

Solvent ....water....

(2)

(ii) Explain what is meant by the term saturated solution.

....A solution in which no more solute can....

....be dissolved....

(1)

(iii) Calculate the mass of potassium nitrate which would dissolve in 100 cm^3 of the warm water to give a saturated solution.

....If 140 g dissolves in 200 cm^3 water....

....70 g dissolves in 100 cm^3 water....

(2)

(iv) Use your answer to part (iii) and the graph to find the temperature of this saturated solution of potassium nitrate.

....44 °C....

(2)

(b) Another saturated solution of potassium nitrate in 100 cm^3 water was cooled from 50 °C to 24 °C. Solid potassium nitrate was formed.

Use the graph to calculate the mass of solid potassium nitrate formed.

....82 g − 36 g = 46 g....

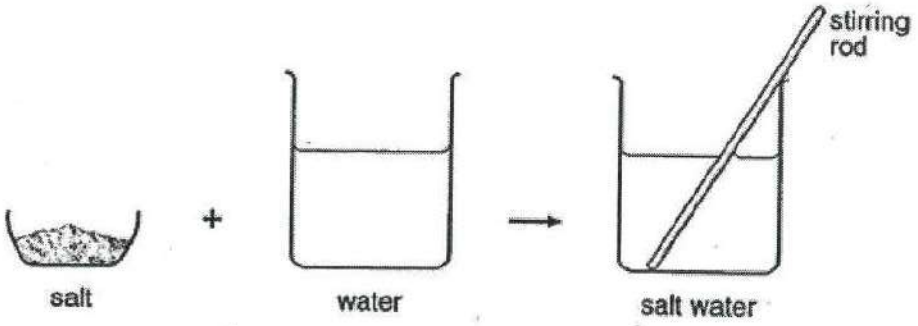
....

....

(3)

(Total 10 marks)

3) Emma dissolved some salt in some water to make salt water.



(a) Which words in the list below describe the salt, the water and the salt water? Write the correct words in the table.

3 marks

solution **solute** **sediment** **filtrate** **solvent**

substance	word from the list
salt	solute
water	solvent
salt water	solution

(b) What two things could Emma do to make the salt dissolve more quickly?

2 marks

1. heat the solution

2. stir the solution

(c) Emma dissolved 5 g of salt in 50 cm^3 of water. Now she wants to make some salt water which is only half as concentrated. What should she do? Tick the correct box.

1 mark

Dissolve 10 g of salt in 100 cm^3 of water.	☐	Dissolve 5 g of salt in 100 cm^3 of water.	✓
Dissolve 10 g of salt in 50 cm^3 of water.	☐	Dissolve 5 g of salt in 25 cm^3 of water.	☐

maximum 6 marks

4) Decide if each of the statements below is true or false. Explain why you think this.

a) Filtering will separate a dissolved solid from a liquid.

This is (true/(false)) because

the dissolved solid will become part of the filtrate if solution is filtered

b) If you add more solid to a saturated solution it will dissolve.

This is (true/(false)) because

saturated means that no more solute can be dissolved.

c) If you pour some water into a wide, shallow dish, more solid will dissolve.

This is (true/(false)) because

size or shape of container does not affect solubility.

d) If you stir a saturated solution, more of the solid will dissolve.

This is FALSE because

Stirring does not affect solubility (only how fast something dissolves

e) If you add more liquid to a saturated solution, more of the solid will dissolve.

This is (true/false) because

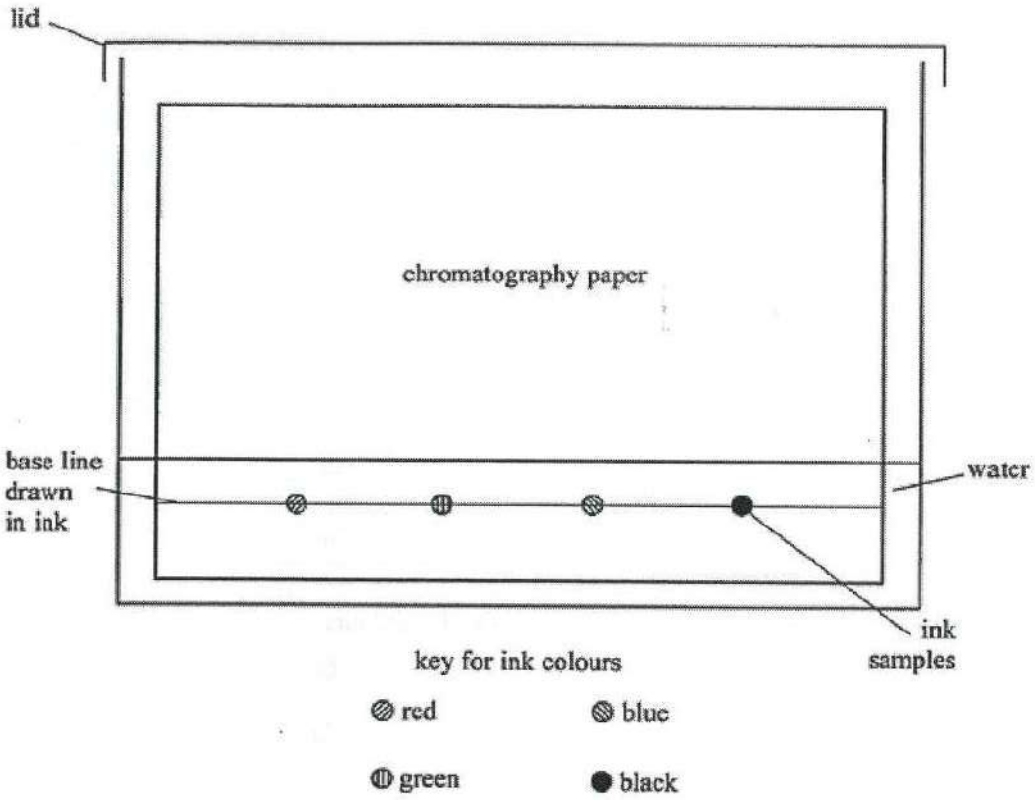
more solid will dissolve however solubility will not change very much.

f) If you heat a saturated solution, less of the solid will dissolve.

This is (true/(false)) because

increasing the temperature increases the solubility of a solution.

5) A student investigates the colours contained in inks from felt-tip pens. He uses chromatography and sets up his experiment as shown:



(a) Identify **two** mistakes in the way he sets up the experiment. For each mistake state what problem it would cause.

First mistake ..base line drawn in ink..

.....

Problem ..base line will end up be.....

.....chromatography paper with solvent.....

Second mistake ..ink samples are below base.....

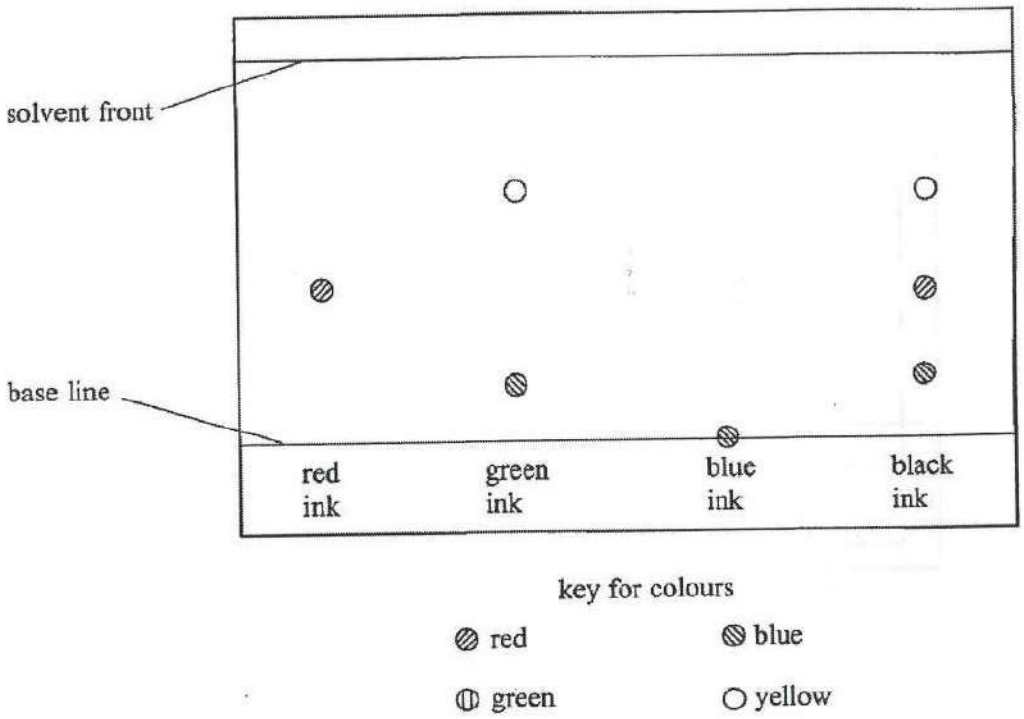
.....line solvent the level.....

Problem ..all ink samples will be dissolved.....

.....in the solvent.....

(4)

Another student repeats the experiment, but does not make any mistakes. She uses inks from four different felt tip pens. The diagram shows her results.



(b) (i) How many different colours does the black ink contain?

3

(1)

(ii) Which of the inks tested could be mixed together to make the black ink?

red + green

(1)

(iii) Which of the inks tested is insoluble in water? Explain your answer.

Ink blue

Explanation did not move from the base line at all.

(2)

(c) R_f values can be calculated for spots obtained by chromatography. The R_f value of a spot is calculated using the equation

$$\mathbf{R_f = \frac{distance\ moved\ by\ spot\ from\ base\ line}{distance\ moved\ by\ solvent\ front\ from\ base\ line}}$$

(i) Use the diagram of the results to help you complete the table. Include units.

distance moved by red spot from the base line	2.1
distance moved by solvent from the base line	5.4

(3)

(ii) Using the values you have recorded in the table, calculate the R_f value for the red spot.

$= \frac{2.1}{5.4} = 0.39$

(1)

(Total 12 marks)

6) The box shows some methods that can be used in separating mixtures.

crystallisation	dissolving	evaporation	filtration
paper chromatography	simple distillation		fractional distillation

From the box, select the best method for each of the separations.

You may use each method once, more than once or not at all.

(a) Removing sand from a mixture of sand and water. (1)

Filtration

(b) Obtaining pure water from a salt solution. (1)

simple distillation

(c) Extracting the red dye from a sample of rose petals. (1)

Chromatography

(d) Separating the coloured dyes in a sample of green ink. (1)

chromatography

(e) Obtaining ethanol (alcohol) from a mixture of ethanol and water. (1)

fractional distillation

7) (a) The list shows some techniques used to separate mixtures.

A crystallisation

B filtration

C fractional distillation

D paper chromatography

E simple distillation

Complete the table to show the best method of obtaining each substance from the mixture.

In each case, choose one of the letters A, B, C, D or E. Each letter may be used once, more than once or not at all.

(4)

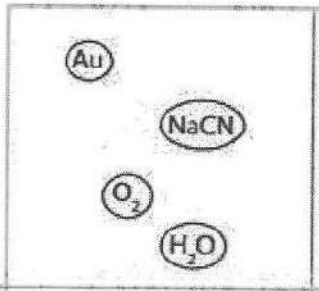
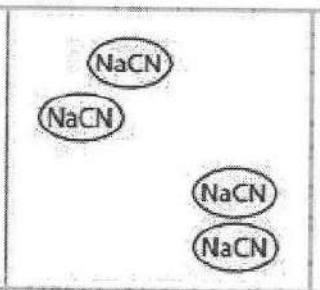
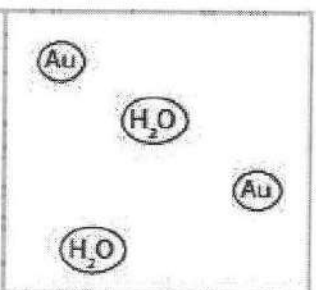
Substance	Mixture	Letter
sand	sand and water	B
solid copper(II) sulfate	aqueous copper(II) sulfate	A
red food dye	mixture of food dyes	D
kerosene	crude oil	C

(b) Gold occurs in ores, which are mixtures of gold and other substances. Several elements and compounds are used in the extraction of gold from its ores.

Each box below represents the substances present in one part of the extraction process.

Classify the contents of each box as a compound, an element or a mixture by writing your choice below each box.

(3)

			
Compound, element or mixture	mixture	compound	mixture