THE DUSTON SCHOOL
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TDS 4-19

# Year 9 Science Knowledge Booklet

## Term 6

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| **Name:** | **Class:** |
| **Homework 1 Due: 9th June** | **Homework 2 Due: 23rd June** |
| **Homework 3 Due: 7th July** | |

# Science Homework 1

Read all of this knowledge organiser.

**Big questions:**

**What is the difference between a pure substance and a formulation?**
**How can we separate pure substances?**
**How do we test for common gases?**
**How has the Earth's atmosphere changed over time?**
**Why are scientists concerned about rising CO2 levels?**
**Why is methane production a concern?**
**What other pollutants can harm the environment?**
**How is water made safe to drink?**
**What practical techniques can be used to show that drinking water is not a pure substance?**
**What are the common techniques used to extract metals from their ores?**
**What techniques are required to extract metal from low-grade ores? (Higher only)**
**Why are life cycle assessments useful in industry?**

**Key vocabulary**

| | |
|---|---|
| **Atmosphere** | A layer of gases surrounding the Earth |
| **Bioleaching** | Uses bacteria to produce leachate solutions that contain metal compounds from which metal can be isolated |
| **Chromatography** | A separation technique that splits substances based on their relative attraction to either the mobile phase or stationary phase |
| **Climate change** | A change in global / regional climate patterns. This is the general weather conditions over a long period of time |
| **Formulation** | A formulation is a mixture that has been designed as a useful product. They are made useful components in carefully measured quantities |
| **Greenhouse effect** | The trapping / retention of heat by the atmosphere due to presence of gases such as carbon dioxide, methane and water vapour |
| **Life cycle assessments** | Process used to identify the environmental impact of products over each stage in the course of its production, use and disposal |
| **Phytomining** | Uses plants to absorb metal compounds, which are then harvested burnt and the metal compounds isolated |
| **Pollutant** | A harmful chemical released into the environment. |
| **Potable water** | This is water which is suitable and safe to drink. It is not pure water as it has other dissolved substances |
| **Pure** | A pure element or compound is not mixed with any other substance, they melt and boil at specific temperatures |

## C8 Chemical Analysis

### What is the difference between a pure substance and a formulation?

The majority of substances used in everyday life are mixtures, which means that they are made up of more than one type of substance that is not chemically bonded to the other.

Each substance has a specific melting/boiling point if it is pure, and mixtures retain many of the original properties of the individual substances. However, the melting / boiling points can be altered, like adding salt to water to lower the melting point or increase the boiling point.

In everyday life, many products are complex mixtures that require specific amounts of each substance to ensure consistency in the product. For example, medicines, foods and drinks, fuels and alloys.

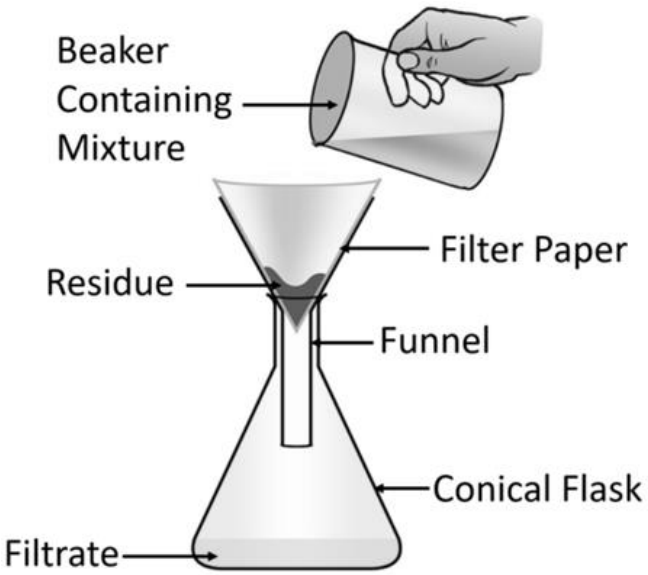
In a formulation, every chemical has been added in a carefully measured amount. Each chemical has a specific purpose in the formulation. With formulations, each component is there for a specific purpose. E.g in medicines the substance that is actually needed to treat a condition is referred to as the active ingredient.

### How can we separate pure substances?

In mixtures, the different substances are not chemically bonded together. Because of this, they can often be separated by relatively simple techniques.

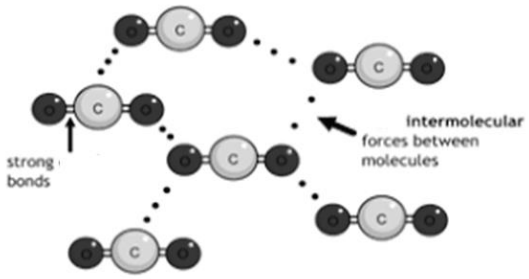
**Filtration**

- Filtration can be used to separate a liquid from an insoluble solid.
- It is also used to separate a solution from a solid that is mixed with it, but not dissolved.



**Evaporation**

- Evaporation is the process where a liquid turns into a gas.
- The intermolecular forces in the liquid are overcome and broken; separating the particles.

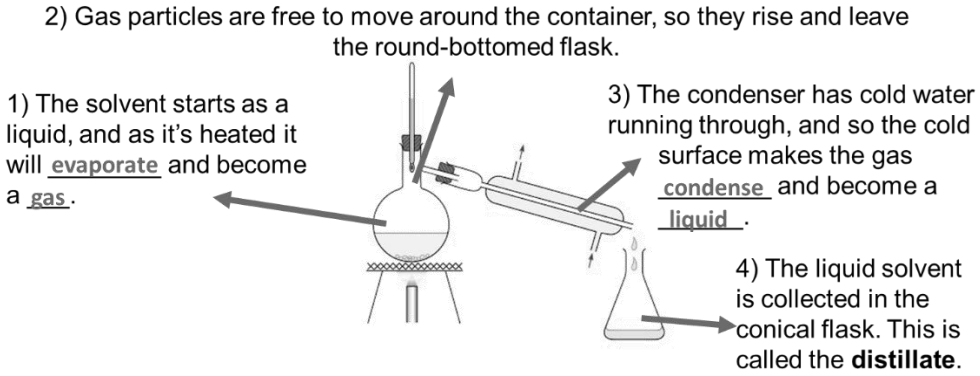



**What is the difference between boiling and evaporation?**

- Boiling occurs at the boiling point of a substance.
- It is typically accompanied by bubbling as the gas escapes the liquid.

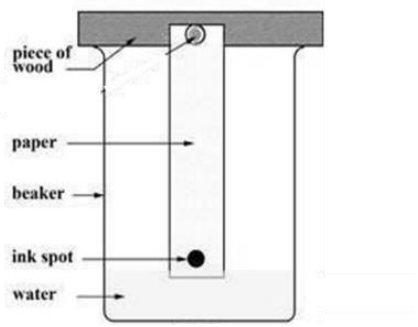
**Distillation**

- **Soluble solids and liquids –** the solvents will evaporate and leave the solid in the round-bottomed flask
- **Liquids of different boiling points -** the liquid with the lower boiling point will evaporate off; leaving the liquid with the higher boiling point in the round-bottomed flask.




**Chromatography**

- Chromatography is used as a way of checking to see if a substance is a mixture or pure, and as a means of comparing one unknown against known substances.
- If different solutions are mixed together, they can also be separated by their solubility.



**How do we test for common gases?**

| Gas | Test | Observation |
|---|---|---|
| Oxygen | Glowing splint held in a test tube | Splint relights |
| Hydrogen | Lighted splint held in a test tube | Pop sound heard |
| Carbon Dioxide | Gas bubbled through limewater | Limewater turns milky or cloudy white |
| Chlorine | Damp litmus paper held in a test tube | Paper turns white |

| C8 Key knowledge question | Answer |
|---|---|
| What is the term for carefully measured mixture designed for a specific purpose? | Formulation |
| What is a pure substance? | A substance made from only one type of substance |
| How can a pure substance be identified by its melting point? | It has a definite melting point |
| How can the purity of different coloured dyes be investigated? | Chromatography |
| In chromatography, why is the line drawn in pencil? | So it does not dissolve/move with the water |
| What is the equation to calculate the $R_f$ value? | $R_f = \frac{\text{distance to spot}}{\text{distance to solvent front}}$ |
| How can an insoluble solid be separated from a liquid? | Filtration |
| How can a soluble solid be separated from a solution? | Evaporation/crystallisation |
| How can two liquids with different boiling points be separated? | Distillation |
| What is the test for hydrogen? | A lit splint makes a squeaky pop |
| What is the test for oxygen? | A glowing splint relights |
| What is the test for carbon dioxide? | Limewater turns from colourless to cloudy white |
| What is the test for chlorine? | Damp blue litmus paper turns red then bleaches white |

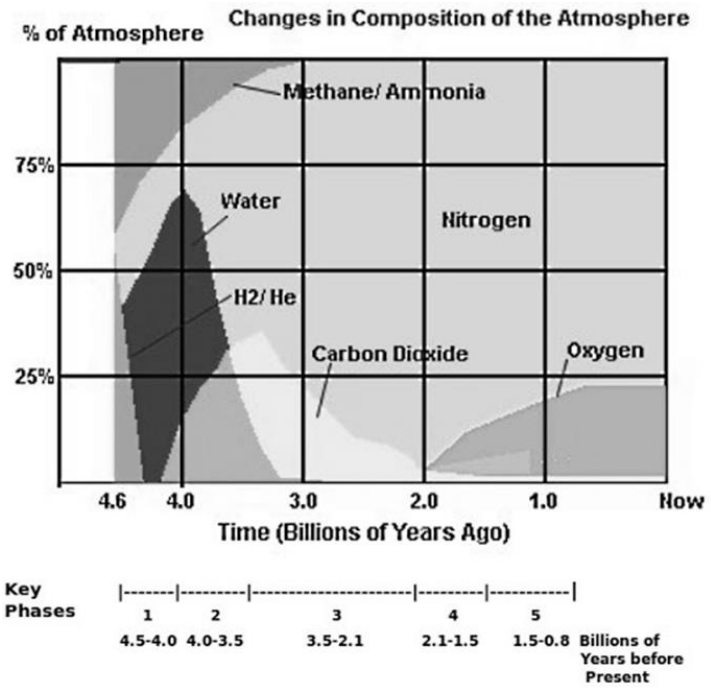
## C9 Chemistry of the Atmosphere

### How has the Earth's atmosphere changed over time?

The atmosphere is the layer of gases surrounding the planet. It is essential for life, without it life wouldn't exist. The composition of the atmosphere has changed compared to the early atmosphere, and is still changing today due to human influences.

Earth's atmosphere is composed of about 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon, and 0.1 percent other gases. Trace amounts of carbon dioxide, methane, water vapour, and neon are some of the other gases that make up the remaining 0.1 percent.

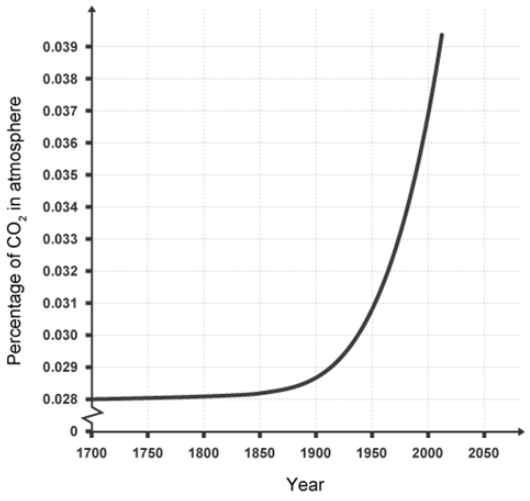
The Earth's atmosphere has not always been this way, it has been relatively constant for hundreds of millions of years.




### Why are scientists concerned with rising $CO_2$ levels?

Rising $CO_2$ levels are creating concern in the global community due to their impact on the Earth's atmospheric temperature. This is because $CO_2$ is an example of a greenhouse gas.

A greenhouse gas is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere. By increasing the heat in the atmosphere, greenhouse gases are responsible for the greenhouse effect, which ultimately leads to global warming.




### Why is methane production a concern?

Methane is also a greenhouse gas and is produced by cattle and rice farming.

# Science Homework 2

Try to answer all of these key knowledge questions. Then check your answers using the last page.

| **C9 Key knowledge questions** | **Answer** |
|---|---|
| What are the top three most abundant gases in the atmosphere? | |
| What are the percentages for the top three most abundant gases in the atmosphere | |
| Why did carbon dioxide levels increase in the early atmosphere? | |
| Why did the percentage of water vapour decrease? | |
| Why did the percentage of carbon dioxide decrease when the oceans formed? | |
| Why did the percentage of carbon dioxide decrease when plants evolved? | |
| Why did the percentage of oxygen increase when plants evolved? | |
| What is incomplete combustion? | |
| Which two harmful products are formed by incomplete combustion? | |
| Name three greenhouse gases. | |
| Why is carbon monoxide dangerous? | |
| What problems are caused by carbon particulates | |
| How is sulfur dioxide produced? | |
| What problems does sulfur dioxide cause? | |
| How are nitrogen oxides produced? | |
| What problems do nitrogen oxides cause? | |

## C10 Using Resources

### How is water made safe to drink?

Water is essential for life. Water that is safe for humans to drink is called **potable water**. Potable water is not pure water because it almost always contains dissolved impurities.

For water to be potable, it must have sufficiently low levels of dissolved salts and microbes.

Most potable water in the UK is produced from naturally occurring fresh water by:

1. Sedimentation – allowing large particles to settle to the bottom
2. Filtrations passing the water through filter beds to remove insoluble particles
3. Sterilisation - sterilising the water to kill microbes using chlorine, UV or ozone

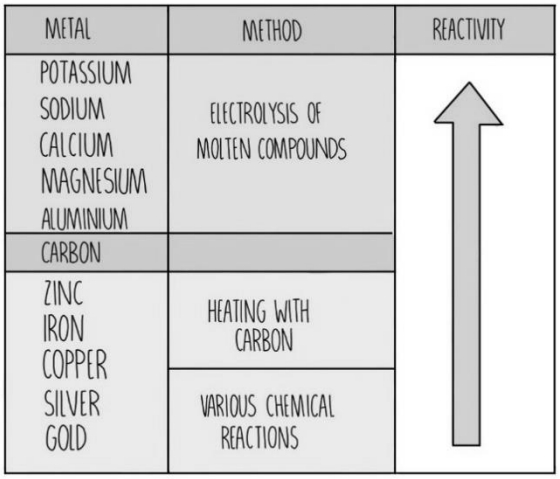
The methods used for sterilisation include chlorine, ozone and ultraviolet light.

Waste water is treated by:

Screening, sedimentation and anaerobic and aerobic respiration

### What are the common techniques used to extract metals from their ores?

Unreactive metals, such as silver and gold, can be found in the Earth's crust in a pure form, un-combined to other elements. However, more reactive metals, such as aluminium and magnesium, will usually be found combined to another element in a compound. An **ore** is a rock that contains enough of the metal to make it economically worth extracting**.**

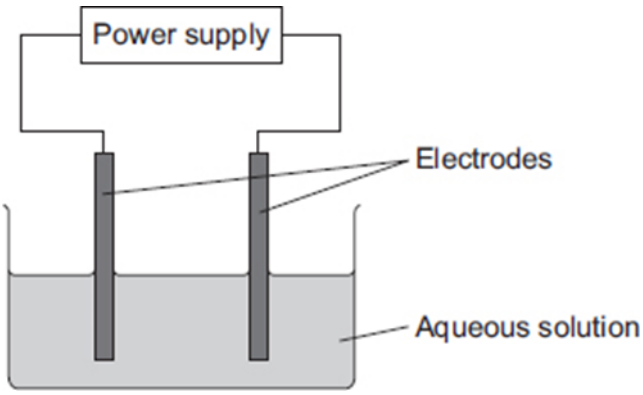



**Extraction methods**

The method of extracting a metal depends on its position in the reactivity series.

If a metal is **less reactive than carbon**, it can be extracted by reacting it with carbon in a displacement reaction.

Elements which are **more reactive than carbon** will be extracted using **electrolysis**. Aluminium is more reactive than carbon so it must be extracted from ores containing aluminium oxide using this method.

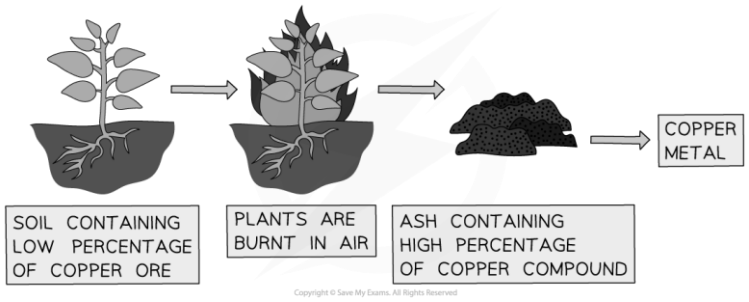


**What techniques are required to extract metal from low-grade ores? (Higher only)**

- Extraction of metal ores from the ground is only economically viable when the ore contains sufficiently high proportions of the useful metal, such as iron ores and aluminium ores.
- For low grade ores (ores with lower quantities of metals) other techniques are being developed to meet global demand.
- This is happening in particular with nickel and copper as their ores are becoming more and more scarce.
- Phytomining and bioleaching (bacterial) are two relatively new methods of extracting metals that rely on biological processes.
- Both of these methods avoid the significant environmental damage caused by the more traditional methods of mining.

**Phytomining**

This process takes advantage of how some plants absorb metals through their roots




**Bioleaching**

- Bioleaching is a technique that makes use of bacteria to extract metals from metal ores.
- 
- Some strains of bacteria are capable of breaking down ores to form acidic solutions containing metals ions such as copper(II).
- The solution is called a leachate which contains significant quantities of metal ions.
- The ions can then be reduced to the solid metal form and extracted by displacement reactions or electrolysis.

**Why are life cycle assessments useful in industry?**

A life-cycle assessment or LCA analyses the impact of a manufactured product.
The main stages analysed as part of a life-cycle assessment are:

- **Raw Material Extraction**
- **Manufacturing & Processing**
- **Transportation**
- **Usage & Retail**
- **Waste Disposal**

The life-cycle assessment is a complex process and judgements are not exact. For example, people do not always follow the disposal advice from the manufacturer.

# Science Homework 3

Try to answer all of these key knowledge questions. Then check your answers using the last page.

| C10 Key knowledge question | Answer |
|---|---|
| What is potable water? | |
| What is pure water? | |
| What are the stages of water purification? | |
| Which process of water purification removes salt from sea water | |
| What are the stages of waste water treatment? | |
| Give three ways metals can be extracted | |
| What is an ore? | |
| How are metals below carbon in the reactivity series extracted from their ores? | |
| How are metals above carbon in the reactivity series extracted from their ores? | |
| Give two methods to extract metals from low grade ores | |
| What is a life cycle assessment? | |

| **C9 Key knowledge questions** | **Answer** |
|---|---|
| What are the top three most abundant gases in the atmosphere? | Nitrogen, oxygen, argon |
| What are the percentages for the top three most abundant gases in the atmosphere | 78%, 21%, 0.9% |
| Why did carbon dioxide levels increase in the early atmosphere? | Volcanic activity |
| Why did the percentage of water vapour decrease? | Water vapour condensed as the Earth cooled to form the oceans |
| Why did the percentage of carbon dioxide decrease when the oceans formed? | Carbon dioxide dissolved in the oceans |
| Why did the percentage of carbon dioxide decrease when plants evolved? | Plants absorb carbon dioxide for photosynthesis |
| Why did the percentage of oxygen increase when plants evolved? | Plants release oxygen during photosynthesis |
| What is incomplete combustion? | Combustion with not enough oxygen |
| Which two harmful products are formed by incomplete combustion? | Carbon monoxide and carbon particulates |
| Name three greenhouse gases. | Carbon dioxide, methane, water vapour |
| Why is carbon monoxide dangerous? | Carbon monoxide takes the place of oxygen in blood |
| What problems are caused by carbon particulates | Breathing problems and makes buildings look dirty |
| How is sulfur dioxide produced? | Impurities (sulfur) in coal react with oxygen |
| What problems does sulfur dioxide cause? | Acid rain and breathing problems |
| How are nitrogen oxides produced? | Nitrogen and oxygen react at high temperatures in car engines |
| What problems do nitrogen oxides cause? | Breathing problems and acid rain |

| **C10 Key knowledge question** | **Answer** |
|---|---|
| What is potable water? | Water that is safe to drink |
| What is pure water? | Water that contains only $H_2O$ with nothing dissolved in it |
| What are the stages of water purification? | Sedimentation, filtration, sterilisation |
| Which process of water purification removes salt from sea water | Desalination |
| What are the stages of waste water treatment? | Screening, sedimentation and anaerobic and aerobic respiration |
| Give three ways metals can be extracted | Found as pure metals, reduction with carbon, electrolysis |
| What is an ore? | An **ore** is a rock that contains enough of the metal to make it economically worth extracting**.** |
| How are metals below carbon in the reactivity series extracted from their ores? | By reacting it with carbon in a displacement reaction. |
| How are metals above carbon in the reactivity series extracted from their ores? | They are extracted using **electrolysis.** |
| Give two methods to extract metals from low grade ores | Phytomining, bioleaching |
| What is a life cycle assessment? | A life-cycle assessment or LCA analyses the impact of a manufactured product. |