Models of the atom over time

Introduction

Early scientists thought that atoms were tiny solid spheres that could not be made any smaller.

Today's chemists now know the atom is made of neutrons, protons and electrons. A positive nucleus, containing protons and neutrons, is orbited by negative electrons. Most of the atom is empty space. So what led to the changes in our ideas about the atom?

In this WebQuest you are going to:

- find out the key discoveries made about the atom
- research the major findings and discover how these have changed our understanding of atomic structure.

Task

You will carry out research into how the model of the atom has changed over time. You will use your research to produce a detailed timeline of the major discoveries.

Your timeline will need to cover the following things:

- Who made the discovery?
- What did they discover and how?
- What did this tell them about the atom?
- How did this change the model of the atom?

Try to include a diagram or picture for each model of the atom in your timeline.

Process

Step 1 – Carry out your research

Find out about:

- what early scientists and philosophers thought particles and atoms were like
- the 'plum pudding model' of the atom
- Rutherford and Marsden's gold foil experiment
- the discovery of protons
- Niels Bohr's revised model of the atom
- James Chadwick's discovery of the neutron.

You will need to think about what evidence the scientists collected and how this changed our understanding of the atom.

Step 2 – Prepare your timeline

Your timeline will need to be in the style of a poster. It should put key dates in chronological order. Each discovery should have a description of how and why the scientists carried out the experiment, and what they found out.

Your timeline should also include a diagram or picture for each model of the atom, so that the changes can be seen.

Step 3 – Present your timeline

Make sure your timeline is complete, accurate and easy to read. Your teacher may want to use the timelines for a display, or you may be asked to show your timeline and explain the key findings.

Sources

Early ideas about matter

The first two sections of this webpage discuss what matter was thought to be like in ancient times. They describe how early philosophers came to think there must be tiny particles that could not be broken apart into anything smaller.

https://www.visionlearning.com/en/library/Chemistry/1/Early-Ideas-about-Matter/49

The plum pudding model

This website gives a general overview of the plum pudding model.

http://www.cambridgephysics.org/nucleus/nucleus1_1.htm

Problems with the plum pudding model

This website discusses the plum pudding model and some of the reasons it failed.

https://www.universetoday.com/38326/plum-pudding-model/

The gold foil experiment and its impacts on the model of the atom

This website gives lots of information about the gold foil experiment carried out by Rutherford and his assistants, and how this changed our understanding about the atom. The website also includes a useful animation of the experiment.

https://www.bbc.co.uk/bitesize/guides/z29rsrd/revision/1

The work of Niels Bohr

The first section of this website describes the work that Niels Bohr carried out and what he discovered about the atom. You do not need to read the sections about liquid droplets or quantum theory in order to build your timeline.

https://www.livescience.com/32016-niels-bohr-atomic-theory.html

Protons are discovered

This website contains a section called 'Discovery of Proton' giving further details about how the proton was discovered. You should ignore the mathematical equations given on this webpage as you do not need to understand them for your course.

http://padakshep.org/otp/subjects/chemistry/physical-chemistry/discovery-of-electrons-protons-and-neutrons/

Discovering the neutron

This website contains a series of pages describing how neutrons were discovered. The website also includes a useful animation on how neutrons were discovered.

http://www.cambridgephysics.org/neutron/neutron2_1.htm

Conclusion

Through your research and by making a timeline, you should have found out the following:

- Early scientists and philosophers thought matter was made up of tiny particles that could not be broken down any further. These were eventually given the name atoms.
- After discovering electrons, J.J. Thomson proposed that atoms were like 'plum puddings' where negative electrons were embedded in a cloud of positive charge.
- Rutherford and his assistants, Geiger and Marsden, fired alpha particles at gold foil and were surprised when some bounced back. This led them to discover that atoms must have a positive centre, where most of the mass is. This became known as the nucleus. Rutherford carried out further experiments that led him to suggest that the nucleus contained positive particles called protons. This led to the nuclear model, in which negative electrons orbit a positive nucleus.
- Niels Bohr carried out work into atoms and discovered that electrons could only exist at certain energy levels. This led to an adaptation of the nuclear model, where electrons existed in defined shells, or energy levels.
- James Chadwick discovered the neutral particle that contributed to the mass of the nucleus. This became known as the neutron.

Your timeline should include a picture or diagram for each model of the atom. It should discuss in detail the experiments that were carried out. It should also describe the evidence that was used to change the model of the atom over time.

The early Periodic Table

Introduction

There are about 120 known chemical elements. These elements make up the many compounds that are known.

It is helpful to be able to see patterns in the chemistry of the elements. This allows us to make certain predictions about their chemistry and about the chemistry of compounds. The development of the Periodic Table has been the greatest step forward in our understanding of the chemistry of the chemical elements.

In this WebQuest you are going to find out what is meant by the term 'element', and how John Newlands and Dmitri Mendeleev took the first important steps in developing a Periodic Table. Their tables had the elements arranged to show patterns in the properties of the elements.

There were obvious anomalies in both of their tables, where things didn't fit the pattern. You will be asked to find out how these anomalies were accounted for by Mendeleev.

Task

Firstly, you should find a suitable description of a chemical element. Then you will try to find out what work Newlands and then Mendeleev did to develop the Periodic Table. This was not easy to do in those days because there was not much information about elements (or indeed many elements) for them to base any table on. You will need to make it clear how their tables were drawn up. There were some anomalies in Mendeleev's table, which made many people ask questions about it. You will be asked to research how he explained these anomalies and how he was able to make predictions from his table.

You may also be asked to try to find out which major scientific discovery was mainly responsible for the rapid development of the modern Periodic Table in which all these anomalies are resolved.

You may choose to present your findings in the form of a report or as a presentation. Or you could prepare a script for an interview to be given by Mendeleev, in front of an unfriendly audience, in which he tries to justify the positioning of some of the elements in his table.

Process

Step 1: Gathering information on the task

The weblinks included on the 'Sources' page will be helpful in gathering information for this task. Make sure you gather information on each of the following:

- What is meant by the term 'chemical element'?
- What early work was done by John Newlands and Dmitri Mendeleev to develop the Periodic Table?
- How was Mendeleev able to explain the anomalies in his table and how was he able to make predictions from it that could be tested experimentally?

- (optional) Which major scientific breakthroughs were responsible for the rapid development of the modern Periodic Table?

Step 2: Research

You should decide how you are going to select and order relevant information relating to the bullet points above. This will involve using your Student Book or weblinks on the 'Sources' page.

Step 3: Creating your presentation

You must decide how you are going to best organise your findings within the three or four research areas. This could take the form of a report or a presentation. Additionally, you may also choose to prepare a script for an interview to be given by Mendeleev in front of a doubting and unfriendly audience in which he tries to justify the positioning of some of the elements in his table.

Sources

Chemical elements

This webpage provides an interactive Periodic Table, with history, videos, and data on each of the elements.

https://www.rsc.org/periodic-table/?gclid=Cj0KCQjwsYb0BRCOARIsAHbLPhFkHtWvD3WJJ4jFoN_S9J1KgWh6UTIOOslFLvnTic3BInUiX0fm4H4aAuMjEALw_wcB

Newlands's octaves

These webpages give a description of the work of John Newlands in arranging the elements into a Periodic Table.

https://www.bbc.co.uk/bitesize/guides/zfn9q6f/revision/1

https://www.meta-synthesis.com/webbook/35_pt/pt_database.php?PT_id=8

Mendeleev's Periodic Table

This webpage gives a description of the work of Dmitri Mendeleev in arranging the elements into a Periodic Table.

https://origins.osu.edu/milestones/mendeleev-periodic-table-UN-chemistry-radioactivity-noble-gases

Conclusion

You should now understand a lot more about how the early Periodic Table was developed. You will know about some of the scientists involved in creating it and how scientists have to be able to explain their work to others. And do you know what a chemical element is?

Your report, presentation, and possibly your radio/TV interview should include:

- A description of what a chemical element is.
- A description of the contribution made by Newlands and Mendeleev to the development of the early Periodic Table.
- The explanation put forward by Mendeleev to explain away the anomalies clearly present in his table.
- (optional) A description of the scientific breakthroughs responsible for the development of the modern Periodic Table.

Extraction of aluminium

Introduction

Aluminium is a very useful metal. Today it is being used to make lots of things we used to use iron and steel for.

Aluminium has to be extracted from aluminium ore by the electrolysis of aluminium oxide and cryolite. It can't be made in a blast furnace like iron is. This makes it more expensive to produce.

In this WebQuest, you are going to prepare a presentation. Your presentation should:

- describe why aluminium is useful
- give a detailed explanation of what happens during the electrolysis of aluminium and cryolite to obtain aluminium metal.

Task

Your task is to make a presentation to younger students about the extraction of aluminium. In your presentation you need to explain the following:

- What do we use aluminium for? Give at least four examples.
- The formula of aluminium oxide and why is it combined with cryolite during electrolysis.
- Why electrolysis is needed to extract aluminium?
- What state must the electrolysis of aluminium oxide and cryolite take place in? Why?
- What ions are present during the electrolysis of aluminium oxide and cryolite?
- What happens at the anode?
- What happens at the cathode?
- Why does the anode need to be continually replaced?

Process

Use the weblinks to find out as much as you can about all of the questions listed above.

There is a video on the Royal Society of Chemistry weblink. Only watch it if your teacher says you can. It's a very large file.

Sources

Royal Society of Chemistry: Alchemy?

You will find lots of information about aluminium at the following link, including what it is used for. There is also a video showing how aluminium is made in a factory.

https://edu.rsc.org/resources/aluminium-extraction/16.article

WebElements: Aluminium

This website tells you lots about the element aluminium. Use the menus on the left-hand side to find information. Some bits can be read out to you if you click the speaker symbol.

https://www.webelements.com/aluminium/

How is aluminium extracted?

This website describes why cryolite is added to aluminium oxide before electrolysis and describes what happens when the electrolysis is occurring. It also discusses why the anode needs to be replaced frequently.

https://www.bbc.co.uk/bitesize/guides/zxyq4qt/revision/4

What happens at the anode and cathode?

This website gives an overview of the process of extracting aluminium from aluminium oxide and how it was developed. There is a useful section at the end showing what occurs at the anode and cathode. Half equations are given, but these do not need to be included in your presentation.

https://ibchem.com/IB/ibnotes/full/ope_htm/hall_cell.htm

Conclusion

There is a lot of aluminium in the Earth's crust. But extracting it is difficult and expensive.

Points to remember when putting your presentation together:

- Don't just copy large sections from the sources you use.
- Make sure you read the information you are using so you can pick out the important bits.
- Your presentation needs to be snappy and to the point – you don't want to waffle about things that aren't important.

Your presentation should have explained that aluminium oxide and cryolite are mixed together and melted. The cryolite is added to lower the melting point and reduce the energy required. It should have explained in detail that aluminium oxide breaks apart into ions, and that these ions move to the oppositely charged electrodes. At the anode, oxygen ions lose electrons to become oxygen gas and at the cathode, aluminium ions gain electrons to form aluminium metal. You should have explained that the carbon in the anode reacts with oxygen to form carbon dioxide and so this electrode has to be replaced frequently.

Catalytic nanoparticles

Introduction

The production of most industrially important chemicals involves the use of catalysts. Catalysed reactions are preferred in environmentally sensitive 'green chemistry'. In this WebQuest you are going to find out what is meant by the term 'catalyst'. You will also find out just why catalysts are so important to the chemical industry.

Nanoparticles are engineered to have sizes between about 1 nm and 100 nm (nanometres). They have properties that are not found in bulk samples of the same material. There is now a move to make use of this new technology by having catalysts made up of nanoparticles.

In this WebQuest you are going to:

- find out the advantages to a chemical company (and the environment) of using catalysts made up of such small particles
- research a number of chemical processes that have catalysts composed of nano-sized particles.

Task

First, you need to find a suitable definition of a catalyst. Then you will try to find out why chemical companies spend such a vast amount of time and effort to find suitable catalysts for the processes they use. You should also find out how the use of catalysts can impact positively on the environment.

Next, you need to find out about nanoparticles and how they can be used to make catalysts so much more effective. You should then gather information on at least two processes that use these special catalysts.

You may choose to present your findings in the form of a report or a presentation. Alternatively you might want to prepare a script for one of your group to act as a representative of a company being interviewed by a local radio or TV station about their use of these new catalysts.

Process

Step 1 – Introduction

The weblinks included on the 'Sources' page will be helpful in gathering information for this task.

Gather information on each of the following:

- what catalysts are and how they work
- why catalysts are important, both economically (for chemical companies) and environmentally
- two examples where nanoparticle technology has been applied to the use of catalysts.

Step 2 – Research

Decide how you are going to select and order relevant information relating to the bullet points above. This will involve using your Student Book and the links on the 'Sources' page.

Step 3 – Presentation

When you have completed your research, you must decide how you are going to best organise your findings within the three research areas. This could take the form of a report, a presentation or a script for a radio/TV interview. The audience may have read about the possible risks posed by nanoparticles and you must try to calm any fears they may have and educate them about the scientific reasons the nanoparticles are so useful to the reactions.

Sources

What do catalysts do?

This describes the effect that adding a catalyst has on a reaction, and why.

https://www.chemicool.com/definition/catalyst.html

How can nanotechnology improve fuel cells?

This describes a nanotechnology catalyst that improves the process for purifying hydrogen for use in fuel cells.

https://www.understandingnano.com/fuel-cells.html

What is a nanoparticle?

This website describes what a nanoparticle is.

https://www.horiba.com/uk/scientific/products/particle-characterization/applications/what-is-a-nanoparticle/

Gold nanoparticle catalysts

This describes the use of gold nanoparticles as catalysts in selective oxidation reactions.

https://www.rsc.org/images/Gold%20Nanoparticles_tcm18-189793.pdf

Use of nanoparticles in cosmetics questioned

A newspaper account of the possible risks of using nanoparticles in cosmetics and sunscreens.

https://www.theguardian.com/science/2008/nov/05/cosmetics-beauty-nanoparticles-royal-society

Conclusion

In carrying out this activity, you will have learnt more about how catalysts lower the energy needed for reactions by lowering the activation energy of a reaction. You will also have learnt that nanoparticles are extremely small particles that can have unique properties and that these are being used as catalysts in many new processes.

When you are preparing your report, presentation or interview, remember to include:

- a description of what a catalyst is and what it does
- a description of what nanoparticles are and what advantages and potential dangers they present
- a discussion of the use of nanoparticles as catalysts in at least two industrial processes.

Cracking

Introduction

Crude oil is a source of hydrocarbons. Many of the hydrocarbon fractions are extremely useful, but some are made from very long hydrocarbon chains and this limits their uses.

Further useful substances can be obtained from crude oil fractions using a process called cracking. You may have seen a demonstration of cracking in your science lessons. But why is cracking carried out? What actually happens and are the products obtained really that useful?

In this WebQuest you will:

- research cracking and find out how it works
- discover some of the useful products that can be obtained from cracking.

You will present your findings in the form of an advertising campaign. Your campaign will be used by the chemical industry to advertise cracking to potential investors or foreign countries, who may wish to build new cracking plants for themselves and want to find out about the process.

Task

Research the following areas for your marketing campaign:

- Why is it necessary to change, or refine, the products found in crude oil?
- What is cracking and how does it work?
- How does industrial cracking take place (how does this relate to any demonstrations of cracking you may have seen)?
- What useful products are made from cracking?
- What materials can be made from the products of cracking?

Why are these products so important, for example to consumers and the economy? Prepare a storyboard for your advertising campaign. You could design it as a scripted television advert lasting around two minutes, or you may want to design a series of pages (up to four pages) for a marketing website about cracking.

Process

Step 1 – Research

Use the websites listed on the sources page as a starting point for your research. You can also use your Student Book.

Step 2 – Prepare your marketing campaign

Come together as a group and share the information you have found from your research. You will need to map out your marketing campaign in a logical order and decide what images, text or voice-over you will need to include. You should keep the information succinct and to the point. It should also assume the audience has no previous scientific knowledge. Make sure your campaign covers all the key points from the task page.

Step 3 – Show your advertising campaign

You may be asked to show your advertising campaign to the rest of your class.

Sources

Cracking alkanes

This gives an overview of the practical demonstration of cracking you may have seen in your lessons and introduces why cracking is carried out industrially. If the video link given does not work, you could search for a clip on another video sharing website using the search term 'cracking of alkanes demonstration'.

https://edu.rsc.org/resources/cracking-hydrocarbons/681.article

What happens during cracking?

This describes what takes place during cracking and the molecules produced. Please note, you do not need to use any of the information about the actual catalysts in this website in your marketing campaign.

https://www.chemguide.co.uk/organicprops/alkanes/cracking.html

Refining oil

This gives an overview of what takes place within an oil refinery.

https://science.howstuffworks.com/environmental/energy/oil-refining5.htm

What happens at the oil refinery?

This gives a detailed account of what takes place in the oil refinery, including numbered diagrams showing where key steps take place. You will only need to consider information in the sections before the section titled 'Isomerisation' for your task.

https://www.essentialchemicalindustry.org/processes/cracking-isomerisation-and-reforming.html

An overview of cracking

This website gives an overview and a useful diagram and animation of what happens during cracking.

http://resources.schoolscience.co.uk/SPE/knowl/4/2index.htm?cracking.html

Polymers

This looks at one class of very useful products we can obtain from cracking products – polymers.

http://www.pythagorasandthat.co.uk/alkenes-and-polymers

Conclusion

Through your research you should have found out that large hydrocarbon chains from crude oil fractions can be cracked into smaller, more useful products, including alkenes. Cracking takes place industrially and requires hydrocarbons to be heated and passed over a catalyst, or heated to very high temperatures in the presence of steam.

Alkenes are extremely useful as they can be made into products such as polymers, which have thousands of uses. They are also the starting material for many other substances. Shorter chain alkanes are also formed through cracking and these are often useful as fuels, for example gasoline or LPG.

You will have produced a marketing campaign (either a storyboard or a series of webpages) about cracking that explains how cracking occurs, the products formed and why it is an essential chemical industry.

Paper chromatography

Introduction

Chemists need quick and reliable ways of determining the purity of substances.

One such method is paper chromatography. You may have carried out some chromatography yourself, perhaps separating the inks in coloured pens, or the dyes in coloured sweets?

Paper chromatography needs to be set up and carried out accurately to ensure reliable results are obtained, especially if it is being used to check the purity of a substance.

In this WebQuest you will:

- research how chromatography can be used to check the purity of a substance
- produce a laboratory guide that could be used to show new laboratory assistants how to set up, carry out and analyse the results from paper chromatography.

Task

You will research paper chromatography and how it can be used to check the purity of a substance.

You will use the information you find to produce a laboratory guide. Your guide should fit on to two sides of A4 paper, so that it could be laminated for easy reference. It should be clear and contain accurate information. It will be useful to include labelled diagrams.

Your guide must include:

- a description of what chromatography is and how it works (including a description of the terms solvent, mobile phase, stationary phase)
- how to set up paper chromatography
- the steps involved in carrying out paper chromatography accurately
- how to analyse the results from paper chromatography (including how to calculate R_f values)
- examples of chromatograms and how they could be used to determine the purity of a substance.

Process

Step 1 – Research

Carry out research on the areas listed above. Use the websites listed on the sources page of this task as a starting point. You may also wish to refer to your Student Book for more information.

Step 2 – Prepare your laboratory guide

You should decide which information needs to be included and the best way to set out your guide. Once this is planned, prepare the guide, remembering to keep to two sides of A4 and to make the information quick and easy to refer to.

Sources

What is paper chromatography?

This is a detailed introduction to paper chromatography, with some helpful diagrams illustrating how the process works. A section on calculating R_f values is also included. You do not need to read beyond the section titled 'Two way paper chromatography' for the purposes of this task.

https://www.chemguide.co.uk/analysis/chromatography/paper.html

A method for paper chromatography

This gives an overview of how paper chromatography is set up. The section for paper chromatography is found on the fourth page of the document (and is labelled 119 in the top right hand corner).

https://edu.rsc.org/resources/chromatography/1301.article

Analysing chromatograms

This gives an overview of chromatography and how it is used in different situations, for example to determine if a sample of a medicine is pure. Some of the chemical names and diagrams used are beyond the level to you need for your studies, so you will not need to understand these.

http://www.mendelset.com/articles/683/thin_layer_chromatography_tlc

R_f values

This site contains a clear section on calculating R_f values, with a labelled example.

http://dept.harpercollege.edu/chemistry/chm/100/dgodambe/thedisk/chrom/wback3.htm

Analysing chromatograms

This gives an example of a chromatogram and explains how R_f values are calculated and what they can tell you. The webpage also describes how chromatograms can be used to check for purity.

http://faculty.sdmiramar.edu/fgarces/LabMatters/ChemTech/modules/paprchrom/paprchrominterp.htm

Conclusion

You have carried out detailed research about paper chromatography and produced a laboratory reference guide about the technique. Your guide will contain useful diagrams and images and will be easy to understand.

Your guide will clearly show how paper chromatography is set up and carried out accurately and how the R_f values of any spots are calculated. You should have explained that spots with the same R_f values are likely to have come from the same substance and that spots with different R_f values will be from different substances.

You will have explained that the paper is known as the stationary phase and the solvent that carries the spots up the paper is known as the mobile phase. Mixtures separate out because of the different attractions between each spot and the stationary phase. R_f values can be used to compare chromatograms.

You will also have shown in your guide that an impure substance will generally produce more than one spot, and this can be used as a guide to whether a substance is pure, although other techniques such as melting point analysis would be needed to confirm if something is actually pure.

The history of the atmosphere

Introduction

In recent years scientists have become concerned about changes in the atmosphere, mainly about the level of carbon dioxide present and the effects this may have. But changes in the atmosphere are not a new phenomenon.

If we could measure the gases present in the environment a million years ago, a billion years ago or when the atmosphere first formed, we would find very different results. The atmosphere has not always been the way it is now.

In this WebQuest you will:

- find out how the atmosphere has changed over time
- discover how we came to find out about the past atmosphere
- use your research to produce a catchy song or poem about how the atmosphere has changed through the Earth's history.

Task

Research how the atmosphere has changed over time.

You will need to use your research to write a catchy song or poem that summarises how the atmosphere has changed.

You will need to cover the following points in your song or poem:

- How do we know about the early atmosphere?
- What was the early atmosphere like and how did it form?
- Why did the atmosphere start to change?
- When did oxygen first appear?
- Why did oxygen first appear?
- What other changes have taken place?
- Will the atmosphere continue to change?

Your song or poem should be no longer than two pages of A4 paper.

Process

Step 1 – Research

Carry out research into the Earth's atmosphere using the suggested websites on the sources page. You may also refer to your Student Book for further information. Make sure that you find out information to answer all the questions given in the task section.

Step 2 – Prepare your song or poem

Use the information you have found out to write your song or poem. Make it catchy and to the point so that it helps people remember key changes in the Earth's atmosphere.

Step 3 – Perform your song or poem

Your teacher may ask you to perform your song or poem to the rest of the class. You may wish to practise your song or poem first.

Sources

How do we know about the Earth's early atmosphere?

This webpage describes various methods that have been used to obtain data on the early atmosphere.

https://www.windows2universe.org/?page=/earth/climate/CDcourses_investigate_climate.html

Can we learn about our atmosphere from the moon?

This webpage discusses how the moon may give us clues about our early atmosphere.

https://earthsky.org/space/what-the-moon-can-tell-us-about-earth

The changing atmosphere

This webpage gives an overview of how the level of carbon dioxide started to fall and levels of oxygen began to rise.

https://www.bbc.co.uk/bitesize/guides/zyd64qt/revision/1

How and why did oxygen appear?

This webpage explains how and why oxygen appeared in our atmosphere.

https://www.bbc.co.uk/bitesize/guides/z82gng8/revision/5

The evolution of the Earth's atmosphere

This webpage gives a detailed overview of the stages in the atmosphere's evolution over time.

http://www.docbrown.info/page21/GeoChangesANS01c.htm

The Earth's atmosphere

This interesting short video on the Earth's atmosphere will help you appreciate what the current atmosphere is like.

https://www.youtube.com/watch?v=1YAOT92wuD8

Conclusion

Through your research you should have found out that the Earth's early atmosphere was very different to today's atmosphere.

The early atmosphere is likely to have been rich in carbon dioxide and nitrogen and some water vapour but no oxygen, and these gases were likely to have come from volcanoes. Over time the earth cooled and water began to condense, forming oceans. Around 3.4 billion years ago organisms began to appear that made their own food by breaking down other chemicals.

About 2.7 billion years ago, organisms appeared that could photosynthesise and this began to raise levels of oxygen and decrease carbon dioxide levels. The amount of lifeforms began to rise, along with the level of respiration. This meant oxygen levels continued to rise and carbon dioxide began to be locked up into living matter and sediments, as dead matter fell to seabeds and river beds and become covered, eventually turning to trapped fossil fuels.

Information on the early atmosphere can be found from sediments in the rock and ice cores, but this does not give data on the very first atmosphere. For this, comparisons can be made with other planets that have atmospheres rich in carbon dioxide and without oxygen.

Capturing carbon

Introduction

Most scientists agree that the Earth is getting warmer and many of them believe that carbon dioxide is partly to blame. Carbon dioxide is produced through many natural processes, but burning fossil fuels is adding to the amount in the atmosphere.

Lots of the carbon we are adding to the atmosphere today has been trapped underground for millions of years, as coal and oil.

It has been suggested that we could capture and store much of the carbon dioxide produced by our power stations and other factories. If we could do that, the carbon dioxide would not go back into the atmosphere so it could not cause more global warming.

In this WebQuest you will:

- research what can be done to capture and store carbon dioxide
- prepare a presentation to be used by a company hoping to build a carbon capture system.

Task

At the end of the lesson you will need to give a presentation. Your teacher will tell you who to give the presentation to.

In your presentation, you need to explain the following:

- why it is important that the power station captures and stores the carbon dioxide it produces, rather than letting it go into the atmosphere
- what long-term effects are possible if climate change occurs
- why the managers at the power station should choose your way of capturing and storing the carbon
- any drawbacks of your carbon capture technique, but how you feel these are outweighed by positive aspects
- why other ways of dealing with the problem are not as good as your way – remember, other people in the class are your competitors.

Process

Step 1 – Research

Find out as much as you can about the points listed above, choosing one way of capturing and storing carbon to promote. Remember too that you need to find as many disadvantages of the other ways to capture carbon. Any problems with other ways of capturing carbon dioxide have to be true. You need to convince the power station managers why your method is superior to other methods being suggested. Include any evidence you have found in your research that backs up the points you make.

Step 2 – The presentation

You will need to give a presentation to a panel of people who are going to pretend to be the power station managers. They will listen to all the presentations and decide which method is the best one. So you need to make it clear just how good your idea is (and how bad the others are).

Point to remember when putting together your presentation:

- Don't just copy large sections from the sources you use.
- Make sure you read the information you are using so you can pick out the important bits.
- Your presentation needs to be snappy and to the point – you don't want to waffle about things that aren't important.
- You should be able to justify any point you make with evidence or facts from the research you carried out.

Sources

The effects of climate change

This website gives an excellent overview of global warming, climate change and the possible effects these may cause.

https://www.metoffice.gov.uk/weather/climate-change/effects-of-climate-change

GreenFacts: Carbon dioxide capture and storage

Lots of information about different ways to capture and store carbon dioxide. Click on the 'Level' tabs to find out more information about each section.

https://www.greenfacts.org/en/co2-capture-storage/

CO_2 Capture project

Explains how to capture and store carbon dioxide in quite a lot of detail. Good diagrams to help you understand what is going on. Use the links at the top to find your way around.

https://www.co2captureproject.org/what_is_co2_capture_storage.html

How stuff works: Carbon capture

Good summary of how carbon capture might work.

https://science.howstuffworks.com/environmental/green-science/carbon-capture.htm

Cool Antarctica

This website explains some of the problems with carbon offsetting.

https://www.coolantarctica.com/Antarctica%20fact%20file/science/carbon_offsetting.php

Conclusion

Scientists are confident that the impact of human production of carbon dioxide has caused, and will continue to cause, global warming.

We need to urgently find ways to reduce the amount of carbon dioxide in our atmosphere to limit the consequences of global warming and climate change.

You will have looked in detail at some of the methods known as carbon capture and considered the advantages and disadvantages of these. What other steps can we all take to reduce our impact on the planet? Could you tell others about the topic you have been learning about, and simple steps they can take to help? Together people can change what happens to the planet, before it is too late.

Potable water

Introduction

Humans cannot survive without water, but not all water is clean. Microbes and dissolved substances in water can cause serious illnesses, or even death.

Treating water to remove microbes and dissolved substances can be done on an industrial scale. However, sometimes it needs to be done on a small scale, for example if people find themselves in remote locations with limited water, or water they cannot be certain is safe to drink.

In this WebQuest you will:

- research why it is essential that water is as free as possible from microbes and dissolved substances
- find out about some of the methods that can be used to treat water, to obtain potable water
- produce an advice sheet for travellers on how they can treat water they find in remote locations so that they can stay healthy.

Task

Your task is to produce an advice sheet for travellers, of no more than two sides of A4 paper. You can produce the advice sheet by hand or use a computer. It should be suitable for being laminated so that people could carry it in their backpacks for easy reference.

Your advice sheet must cover the following:

- why it is essential for humans to have water
- what may be found in water sources (e.g. microbes or dissolved substances)
- why it is important for water to be treated
- methods that are used to treat or purify the water we have in our homes, including a brief explanation of how these methods work
- how water purification can be carried out by travellers in remote locations (including equipment or techniques used to carry out reverse osmosis and desalination).

Process

Step 1 – Research

Carry out research on the following areas:

- Why do humans need to have water in their diet?
- What can be found in untreated water, from actual objects to dissolved substances and microbes?
- What may happen if people do not treat water before drinking it?
- How do the following methods work and how are they carried out:
    - desalination
    - reverse osmosis
    - filtration of water (e.g. commercial water filters)

- adding chlorine to water
- distilling water.

Could any of these methods be suitable for people travelling to remote locations? How? Are there any reasons these methods would not work, or would be difficult?

Step 2 – Produce your advice sheet

Make sure that your advice sheet is easy to understand and use. It must present the key facts in a very accessible way. You must make sure that people who have no scientific understanding could understand it. Include diagrams or pictures in your advice leaflet, particularly if you are describing how a water purification method is carried out, for example.

Sources

Why do we need water?

This webpage looks at some of the facts about why we need water and what happens to our bodies if we don't get enough.

https://kidshealth.org/en/kids/water.html

What might be present in untreated water?

This webpage lists some common contaminants found in untreated water.

https://www.wqa.org/learn-about-water/common-contaminants

Methods of treating water

These webpages outline some of the main methods of treating water.

https://www.cdc.gov/healthywater/drinking/public/water_treatment.html

http://ngoenvironment.com/en/Wastewater-treatment-tec29-PHYSICAL-AND-CHEMICAL-WASTEWATER-TREATMENT-METHODS-d55.html

How has our drinking water been treated?

This webpage gives an overview of how a water company treats the water that ends up as our drinking water. There are numerous links to processes and further information within the page.

https://www.thameswater.co.uk/help-and-advice/water-quality/how-we-look-after-your-water/drinking-water-treatment

How does desalination take place?

This webpage gives an overview of how desalination is carried out.

https://science.howstuffworks.com/environmental/earth/oceanography/how-does-desalination-work.htm

Reverse osmosis

This webpage discusses how reverse osmosis works and how it can treat water.

https://science.howstuffworks.com/reverse-osmosis.htm

How can water be purified in remote locations?

This webpage compares various methods of purifying water, both chemical and physical. Remember that you only need to focus on certain techniques, so only refer to information about these techniques (e.g. filtration and adding chlorine).

https://www.safariquip.co.uk/all-categories/water-purification/choosing-a-water-treatment/

Home-made distillation

This webpage gives some advice on how water can be distilled using everyday items or in unusual situations. The last section of the page outlines how to obtain water from plants, mud or sea water.

https://www.thoughtco.com/making-distilled-water-609427

Conclusion

You will have carried out detailed research into the ways water is treated and used this information to prepare an advice sheet for travellers.

Your advice sheet should explain why it is so important to treat water and the available options for doing so in remote locations.

Through preparing your advice sheet on treating water, you will have become more familiar with the ways water is treated on an industrial scale and considered how these can be adapted by someone in a remote location, in need of potable water. You will have listed several options, such as distillation and desalination and chemical treatment of the water, and considered advantages and disadvantages for each method.

Often the ways of treating water involve large amounts of energy, for example reverse osmosis, or need some form of apparatus to be set up or improvised, such as distillation. Chemical treatment of water is a simple option, but can have other drawbacks, such as altering the taste of water.

Phytomining

Introduction

Rocks can contain large quantities of metals; these are known as ores.

However, these metal resources are becoming scarcer and this makes traditional metal extraction methods uneconomical. Scientists are looking for new ways to obtain metals, particularly from lower grade ores that do not contain such high quantities of metal.

One new technique that may be suitable for extracting metals is phytomining.

In this WebQuest you will:

- research phytomining
- produce an informative article for a science magazine about the technique.

Task

You will carry out research into phytomining and prepare an informative article about the technique. Your article should be aimed at the general public, who may have some interest in science but do not necessarily work in the field of science. Your article will need to be interesting, concise and easy to understand. You should include diagrams to help illustrate the article.

Your article must inform the reader about the following:

- why we need to extract metals
- why alternative methods to traditional metal extraction need to be found
- what phytomining is
- how phytomining works
- examples of where phyomining is being used
- advantages and disadvantages of phytomining
- an overall evaluation of the technique – is it a valuable, safe and effective technique?

Your article should be no longer than two sides of A4.

Process

Step 1 – Research

Carry out research on the areas of the article listed above. Make sure you take accurate notes on what you find out. Make sure you save copies of any useful data or images you find that will be useful for your article. Use the websites listed on the sources page as a starting point for your research. You can also use your Student Book for further information.

Step 2 – Prepare your magazine article

Decide which information will need to be included in your article and the best way to present the information. Make sure you style your information like a magazine article, for example using quotes, images and data to add interest for readers.

Sources

Our need for metals

This article looks at the demand for metals and some of the issues this gives rise to, including the current shortage of some metals in ores.

https://www.bbc.co.uk/news/science-environment-18359287

Copper

This gives a detailed overview of the ways copper can be extracted, including a section on phytomining at the end of the webpage.

http://www.gcsescience.com/ex23.htm

Using plants to extract metals

This webpage explains the research into phytomining being carried out by a UK university.

https://www.york.ac.uk/biology/news-events/news/mining-for-metals/

Is phytomining economical?

This is a discussion of some of the considerations about phytomining and its cost effectiveness.

https://www.miningreview.com.au/phyto-mining-commercially-viable/

Advantages and disadvantages of phytomining

This webpage looks at some of the advantages and disadvantages associated with extracting metals using phytomining.

https://sciencing.com/advantages-disadvantages-phytomining-8661199.html

Conclusion

Now you have completed this WebQuest you will have produced a detailed magazine article about phytomining. In your article you will have given an overall evaluation of the usefulness of the technique, using the information you found.

You will have explained that phytomining is a method used to extract metals from sources that are usually low-grade. High-accumulating plants absorb the metals and the metals can then be harvested, usually by burning the plants.

You will have given some advantages of the technique, such as its low costs as well as it not needing heavy machinery or excavation. You will have also given some disadvantages of the technique, such as the dependence on the weather and the possibility that land would be lost from food production to make space for such metal extraction.

Life Cycle Assessment

Introduction

In the modern world we are becoming more and more aware that the Earth's resources will not last forever. We are also aware that the actions we take in producing goods can affect the environments we live in and the wider world.

Life Cycle Assessments are carried out on goods to find out the impacts that a product has at each stage of its 'lifecycle', from obtaining the raw materials to the disposal or recycling of the product when it is no longer useful or needed.

In this WebQuest you will:

- find out about Life Cycle Assessments
- produce an A3 poster about why Life Cycle Assessments are useful and include information on the Life Cycle Assessment of a product of your choice.

Task

You will produce an A3 poster about Life Cycle Assessments and include a simple Life Cycle Assessment for a product of your choice.

You will first need to research the following things:

- what a Life Cycle Assessment is
- the key stages in a Life Cycle Assessment
- examples of Life Cycle Assessments and how they can have an impact on the sustainability of products.

Then choose a product of your choice and suggest (and draw a summary if possible) what its Life Cycle Assessment may look like. (Avoid choosing a product that is highly complicated or involves many different chemicals or materials, unless you can find detailed information about its Life Cycle Assessment.)

You do not need to provide data for the Life Cycle Assessment for the product you choose, but your poster should describe:

- what a Life Cycle Assessment is and how it is put together
- the product you have chosen
- how obtaining the raw materials for, and making your product, have an impact on the environment
- how the product impacts on the environment through being used, reused or maintained
- how disposing of, or recycling, the product impacts on the environment.

Process

Step 1 – Research Life Cycle Assessments

Research Life Cycle Assessments using the websites listed on the sources page as a starting point. You may also wish to refer to your Student Book for more information. Make sure that you are able to answer all of the points suggested on the task page.

Step 2 – Carry out a Life Cycle Assessment on a product of your choice

Choose a product that will be easy to find information about. For example, if you chose a product such as a car this would be extremely complicated as there are numerous components and materials involved, all of which would need to be considered. You may like to use a paper bag or a plastic bag for your example.

Step 3 – Prepare your poster

Use the information you have found from your research to prepare your poster. Your poster must be no larger than one side of A3 and should be easy to read and interesting to look at. Do not overload the poster with too much information as this makes it difficult to see key points. You must make sure that your poster includes information on what a Life Cycle Assessment is. It also needs to describe your product's impact on the environment through being made, used, reused, maintained, and disposed of or recycled.

Step 4 – Display your poster

Your teacher may ask you to give a brief presentation about your poster**.**

Sources

What is a Life Cycle Assessment?

This webpage gives a brief introduction on what a Life Cycle Assessment is and the key stages it should cover.

https://www.bbc.co.uk/bitesize/guides/zwvq4qt/revision/1

Life Cycle Assessments in practice

This webpage outlines how one major building materials company is using Life Cycle Assessments to improve the sustainability of its practices. On the right-hand side of the page you will find a link to a PDF document called 'Life Cycle Assessment brochure' (check with your teacher before downloading this document). On page 6 and 7 of the brochure is a useful image that outlines the Life Cycle Assessment stages the company goes through.

https://www.british-gypsum.com/about-us/csr/environmental-challenges/environmental-product-declarations

Can a mobile phone be sustainable?

This webpage has an informative poster and information about the Life Cycle Assessment and impacts of a mobile phone.

https://www.appropedia.org/LCA_of_cell_phones

Paper bags versus plastic bags

This webpage has an excellent set of slides about the Life Cycle Assessments of paper bags compared with plastic bags (you can navigate using the grey arrowheads either side of the page title). It suggests several additional activities which you do not need to complete,

unless your teacher tells you otherwise. You do not need to be able to quote any of the data given, but the website should give you a good feel for how the life cycle impacts of items are considered.

http://techalive.mtu.edu/meec/module14/title.htm

Carrier bags and their impacts on the environment

This is a review by the UK government into the use of carrier bags and their impacts on the environment at key stages of their life cycle. The document is very large and you will not need to read, or understand, it all. The conclusion in section 8 (page 59) would be a good starting point as it discusses the overall findings and comparisons between different types of carrier bags. There are also graphs in section 5 showing more detailed data about the life cycle impacts of each type of bag. You do not need to be able to give an analysis of these graphs, but you can compare the different types of bags by looking at variations between the graphs for each.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291023/scho0711buan-e-e.pdf

Conclusion

Through your research you should be more familiar with Life Cycle Assessments and the stages that they consider.

You should have considered a product of your choice and discussed the general stages of its life cycle. For example you may have looked at carrier bags and considered where the plastic needs to come from, the energy needed to manufacture carrier bags and the pollution that comes from this process, along with what happens to them once they are no longer needed and are thrown away.

Although you were not required to give any data about the life cycle of the product you chose, your research should have given you a better insight into the energy and environmental costs associated with manufacturing, using and disposing of products.