# Scheme of work

## Combined Science: Trilogy - Foundation

## Chemistry - Chemistry of the atmosphere

This resource provides guidance for teaching the Chemistry of the atmosphere topic from our new GCSE Combined Science: Trilogy specification (8464). It has been updated from the draft version to reflect the changes made in the accredited specification. These changes are also reflected in the learning outcomes and opportunities to develop skills with some additions to the resources.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 5.9 Chemistry of the atmosphere

#### 5.9.1 The composition and evolution of the Earth's atmosphere

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment**  **Opportunities and resources**  *Reference to past questions that indicate success* |
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| 5.9.1.1 | For 200 million years, the proportions of different gases in the atmosphere have been much the same as they are today:   * about four-fifths (approximately 80%) nitrogen * about one-fifth (approximately 20%) oxygen * small proportions of various other gases, including carbon dioxide, water vapour and noble gases. | MS 1c | 1 | Describe the composition of the atmosphere.  Draw accurate pie charts for the composition of the atmosphere. | Students can use Lego or plasticine to model the proportions of gases in the air: [Lego – Model the molecules in the air](http://d43fweuh3sg51.cloudfront.net/media/assets/wgbh/envh10/envh10_doc_lp58aguess/envh10_doc_lp58aguess.pdf) PDF | Video clip  YouTube:  [BBC Science Bitesize - Changes to the Earth and Atmosphere](https://www.youtube.com/watch?v=6Db2WAG-VVs)  (especially up to 4.05)  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 5.9.1.2 | Theories about what was in the Earth’s early atmosphere and how the atmosphere was formed have changed and developed over time. Evidence for the early atmosphere is limited because of the time scale of 4.6 billion years.  One theory suggests that during the first billion years of the Earth’s existence there was intense volcanic activity that released gases that formed the early atmosphere and water vapour that condensed to form the oceans. At the start of this period the Earth’s atmosphere may have been like the atmospheres of Mars and Venus today, consisting of mainly carbon dioxide with little or no oxygen gas.  Volcanoes also produced nitrogen which gradually built up in the atmosphere and there may have been small proportions of methane and ammonia.  When the oceans formed, carbon dioxide dissolved in the water and carbonates were precipitated producing sediments, reducing the amount of carbon dioxide in the atmosphere. | No knowledge of other theories is required.  Given appropriate information, interpret evidence and evaluate different theories about the Earth’s early atmosphere.  WS 1.1, 1.2, 1.3, 3.5, 3.6, 4.1 | 1 | Draw a comic strip to show how the Earth’s atmosphere has changed from around 4.5 billion years ago (bya) to 600 million years ago (mya).  Draw pictures of the Earth, Venus and Mars and add information about distance to the Sun, % cloud cover, surface temperature, % greenhouse gases for each. Describe how the different temperatures are referred to as the Goldilocks Effect. | Demonstrate the changes in the atmosphere using plasticine or molecular balls or different coloured counters:  [Earth Learning – Using a physical model to show development of our current atmosphere](http://www.earthlearningidea.com/PDF/103_Evolution_atmosphere.pdf)  Students can use coloured jellybeans to represent gases in the atmosphere and model the percentages of different gases (CO2, N2, O2, Ar, CH4) in each of Earth, Venus and Mars (this activity does not reflect atmospheric density).  Students test the acidity caused by dissolved CO2 by blowing into ‘seawater’ and tap water with a few drops of UI to find out which can absorb more CO2 without the acidity changing. | Video clips  YouTube:  [Earth and the Early Atmosphere](https://www.youtube.com/watch?v=Gyn754vw8ZQ)  YouTube: [Evolution of the Earth’s atmosphere](https://www.youtube.com/watch?v=gwGeH9O8Rx4)  Ideas about ancient volcanoes, climate etc:  [NASA website](http://www.nasa.gov/) |
| 5.9.1.3 | Algae and plants produced the oxygen that is now in the atmosphere by photosynthesis, which can be represented by the equation:  light  carbon dioxide + water 🡪 glucose + oxygen  Algae first produced oxygen about 2.7 billion years ago and soon after this oxygen appeared in the atmosphere. Over the next billion years plants evolved and the percentage of oxygen gradually increased to a level that enabled animals to evolve. | WS 1.2 | 1 | Describe how algae and plants have caused the concentrations of oxygen in the atmosphere to increase. | Students can investigate oxygen production in plants using the floating leaf experiment:  [Saps – investigating photosynthesis with leaf discs](http://www.saps.org.uk/secondary/teaching-resources/284-investigating-photosynthesis-with-leaf-discs) |  |
| 5.9.1.4 | Algae and plants decreased the percentage of carbon dioxide in the atmosphere by photosynthesis.  Carbon dioxide was also decreased by the formation of sedimentary rocks and fossil fuels that contain carbon. | Algae and plants decreased Describe the main changes in the atmosphere over time and some of the likely causes of these changes.  Describe and explain the formation of deposits of limestone, coal, crude oil and natural gas.  WS 1.2, 4.1 | 1 | Describe how algae and plants have caused the concentrations of carbon dioxide in the atmosphere to decrease (refers to Biology Carbon Cycle).  Draw a picture to show how dinosaur breath has been locked up in the limestone (exhaled by dinosaurs, photosynthesis by algae, eaten by plankton, become sedimentary chalk). | Students can investigate the colour change of Bromothymol blue when Elodea photosynthesises. An example of the experiment can be found here: [Photosynthesis Lab – Indicating the presence of carbon dioxide](http://www.mbari.org/earth/mar_chem/Iron/Photosynthesis_Lab_1_.pdf)  Students can investigate the production of CO2 (exhaled dinosaur breath) when chalk or limestone is reacted with dilute HCl. |  |

#### 5.9.2 Carbon dioxide and methane as greenhouse gases

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| 5.9.2.1 | Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life.  Water vapour, carbon dioxide and methane are greenhouse gases. | Describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.  WS 1.2 | 1 | Describe the effect of greenhouse gases on wavelength of radiation. | Demonstrate the scattering of light by gases using a torch shining through an aquarium of water and drops of milk (sunset simulation).  Students can role play the effects of different greenhouse gases on radiation: [CMMAP – How do long and short EM waves interact with the Earth's atmosphere](http://www.lsop.colostate.edu/wp-content/uploads/sites/20/2013/07/The-long-and-short-of-it.pdf)?  [CMMAP – What is a greenhouse gas](http://lsop.wolpe2.natsci.colostate.edu/wp-content/uploads/sites/20/2014/10/WhyGasIsGreenhouseGas.pdf)    Demonstrate the effect of greenhouse gases on temperature: [RSC – The greenhouse effect](http://www.rsc.org/learn-chemistry/resource/res00001543/the-greenhouse-effect) | Video clips  YouTube:  [Greenhouse Effect and Global warming](https://www.youtube.com/watch?v=dP-tg4atr5M)  YouTube: [Discovery Channel – Global Warming, What You Need To Know](https://www.youtube.com/watch?v=xcVwLrAavyA)  (long video) |
| 5.9.2.2 | Some human activities increase the amounts of greenhouse gases in the atmosphere. These include:     * carbon dioxide * methane   Based on peer-reviewed evidence, many scientists believe that human activities will cause the temperature of the Earth’s atmosphere to increase at the surface and that this will result in global climate change.  However, it is difficult to model such complex systems as global climate change. This leads to simplified models, speculation and opinions presented in the media that may be based on only parts of the evidence and which may be biased. | Recall two human activities that increase the amounts of each of the greenhouse gases carbon dioxide and methane.  Evaluate the quality of evidence in a report about global climate change given appropriate information.  Describe uncertainties in the evidence base.  Recognise the importance of peer review of results and of communicating results to a wide range of audiences.  WS 1.2, 1.3, 1.6 | 1 | Describe different human activities that increase greenhouse gases.  Students can survey how their families commute in the morning to create a graph.  Examine a graph of global climate change with exaggerated Y axis scale.  Describe what a graph like this leads people to assume. Compare the graph with one with a zeroed scale.  Compare arguments in support and against global climate change. | Watch the NASA video: [NASA Video – 135 years of Global Warming in 30 seconds](https://www.youtube.com/watch?v=---FX0tFCww)  Use the Dr Seuss book/film *The Lorax* and allocate students’ roles (Onceler, the Lorax, Barbaloot/ Hummy Fish/ Truffula Tree, Little Boy) to be interviewed by a pupil reporter about the environmental changes and consequences.  Students can use a simple online model to simulate how emissions affect CO2 levels:  [UCAR – The Very Very Simple Climate Model](http://scied.ucar.edu/simple-climate-model) | Video clip  YouTube:  [The Carbon Cycle](https://www.youtube.com/watch?v=dDBU0lg-HYE)  [National Geographic - Environment](http://environment.nationalgeographic.com/)  [British Antarctic Survey – Search climate change](http://search.antarctica.ac.uk/) |
| 5.9.2.3 | An increase in average global temperature is a major cause of climate change.  There are several potential effects of global climate change | Describe briefly four potential effects of global climate change  Discuss the scale, risk and environmental implications of global climate change.  WS 1.5 | 1 | Describe the effects of global warming for the local and global areas.  Describe the effects of climate change on a local and global scale.  Students can research the effects of climate change on different ecosystems: arctic, coral reefs, wetlands, forests. | Demonstrate the thermal expansion of water by heating water in a conical flask sealed with a capillary tube for expansion.  Students can investigate the difference between ice melting on land compared to sea ice melting by comparing the water level rises in shallow dishes with plasticine land compared to ice floating on water. Melting rises in water level as ice melts.  Link to Maldives sea level rise video: [A Students guide to global climate change – Sea Levels and Expeditions](http://www.epa.gov/climatechange/students/expeditions/sea-level/index.html)  Make a model Earth in a beaker with a layer of dark soil in the bottom. Compare the rise in temperature in a beaker with a cling film lid (greenhouse gases) and uncovered (no greenhouse gases) using a lamp as the Sun. | Video clips:  [BBC Bitesize Causes of climate change](http://www.bbc.co.uk/education/clips/zvw34wx) |
| 5.9.2.4 | The carbon footprint is the total amount of carbon dioxide and other greenhouse gases emitted over the full life cycle of a product, service or event.  The carbon footprint can be reduced by reducing emissions of carbon dioxide and methane. | Describe actions to reduce emissions of carbon dioxide and methane.  Give reasons why actions may be limited.  WS 1.3 | 2 | Describe what a carbon footprint is.  Describe how emissions can be reduced.  Students can suggest what effects their calculated carbon footprint will have on the Earth and atmosphere.  Students suggest ways to reduce their carbon footprint. | Use data to calculate carbon footprints over a school or holiday period  . A person’s carbon footprint can be calculated using a variety of sites such as:  [WWF – Calculate your carbon footprint](http://footprint.wwf.org.uk/)  Students can model a coastline in an aluminium tray using plasticine (including rivers, trees, and towns). Add liquid water to the ocean (half fill the tray). Add a large block of ice at the tallest point of the model. Cover with cling film (greenhouse gases). Make predictions about the outcome for the model town. | Video clip  YouTube:  [Carbon footprints](https://www.youtube.com/watch?v=YB9TCxhjVHo) |

#### 5.9.3 Common atmospheric pollutants and their sources

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| --- | --- | --- | --- | --- | --- | --- |
| 5.9.3.1 | The combustion of fuels is a major source of atmospheric pollutants.  Most fuels, including coal, contain carbon and/or hydrogen and may also contain some sulfur.  The gases released into the atmosphere when a fuel is burned may include carbon dioxide, water vapour, carbon monoxide, sulfur dioxide and oxides of nitrogen. Solid particles and unburned hydrocarbons may also be released that form particulates in the atmosphere. | Describe how carbon monoxide, soot (carbon particles), sulfur dioxide and oxides of nitrogen are produced by burning fuels  Predict the products of combustion of a fuel given appropriate information about the composition of the fuel and the conditions in which it is used.  WS 1.2 | 1 | Write word equations for the complete and incomplete combustion.  Describe how the following pollutants are made in combustion:   * carbon dioxide * carbon monoxide * soot * water vapour * sulfur dioxide * nitrogen oxides.   Describe the products of different fuels from complete and incomplete combustion. | Demonstrate to students the emissions from a car exhaust by showing them a white sock that has covered the exhaust pipe of a running car for 5 minutes (if possible, use one sock on a diesel, one on a petrol car).  Students can build models of pollutants using Lego or plasticine and break them apart to form products of complete combustion: [Lego – Showing burning fuel through a model](http://d43fweuh3sg51.cloudfront.net/media/assets/wgbh/envh10/envh10_doc_lp58afuel/envh10_doc_lp58afuel.pdf)  [Lego – Showing Air chemistry and Pollution through a model](http://d43fweuh3sg51.cloudfront.net/media/assets/wgbh/envh10/envh10_doc_lp58bpollute/envh10_doc_lp58bpollute.pdf)  Students can use Lego or plasticine to model incomplete combustion: [Lego – Model the molecules in air](http://d43fweuh3sg51.cloudfront.net/media/assets/wgbh/envh10/envh10_doc_lp58aguess/envh10_doc_lp58aguess.pdf) | Video clips  YouTube:  [What is combustion?](https://www.youtube.com/watch?v=zEjEqnMBdEM)  YouTube:  [Coal Combustion and Acid Rain](https://www.youtube.com/watch?v=HE6Y0iEuXMQ) |
| 5.9.3.2 | Carbon monoxide is a toxic gas. It is colourless and odourless and so is not easily detected.  Sulfur dioxide and oxides of nitrogen cause respiratory problems in humans and cause acid rain.  Particulates cause global dimming and health problems for humans. | Describe and explain the problems caused by increased amounts of these pollutants in the air.  WS 1.4 | 1 | Describe the effect of the following products:   * Carbon monoxide on the human body. * Sulfur dioxide and oxides of nitrogen on acidity of rain water. * Sulfur dioxide and oxides of nitrogen on respiratory system. * Particulates on global dimming. * Particulates on human health problems. | Demonstrate the effect of different pollutants by adding different substances to a beaker of water:   * Lemonade (SO2). * Cola (NOx). * Red food colouring (CO). * Particulates (carbon powder).   Students can research the effects of their different activities on the production of pollutants to produce their own solutions of ‘polluted air’.  There are various experiments that can test air quality quite simply:   1. Filter paper in funnel test rainwater (examine particulates through microscope). 2. Petroleum jelly on index cards placed in different places outside. |  |