C9 – Chemistry of the Atmosphere

What's the science story?

The Earth's atmosphere is dynamic and forever changing. The causes of these changes are sometimes man-made and sometimes part of many natural cycles. Scientists use very complex software to predict weather and climate change as there are many variables that can influence this. The problems caused by increased levels of air pollutants require scientists and engineers to develop solutions that help to reduce the impact of human activity.

Previous knowledge:

Yr 9 – Photosynthesis, respiration, and ecosystems – link to gases in atmosphere

C8 – Gas tests

Next steps…

B7 – Global warming

Keywords

Oxygen	Greenhouse gases	Pollutants
Nitrogen	Greenhouse effects	Combustion
Carbon dioxide	Fossil fuels	Carbon monoxide
Photosynthesis	Wavelength	Particulates
Methane	Global climate change	Sulfur dioxide
	Global dimming	Nitrogen oxides

Working scientifically skills:

WS1 – Scientific methods – how theories have changed

WS3 – Make predictions

WS4 – Ethical arguments

Assessments:

End of unit test (summative) – out of 50

Exit tickets x 1 (formative)

- Changing atmosphere

Lesson No. and Title	Learning objectives	AQA Specification	Practical equipment
1. The Earth's Atmosphere	4 – To describe the Earth's early atmosphere. 5 – To describe the theory about how our atmosphere developed. 6 – To interpret evidence and evaluate different theories about the early atmosphere.	**5.9.1.1 The proportions of different gases in the atmosphere** 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. **5.9.1.2 The Earth's early atmosphere** 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. Students should be able to, given appropriate information, interpret evidence and evaluate different theories about the Earth's early atmosphere. **5.9.1.3 How oxygen increased** Algae and plants produced the oxygen that is now in the atmosphere by photosynthesis, which can be represented by the equation. 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. **5.9.1.4 How carbon dioxide decreased** 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.	

		Students should be able to: • 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.	
2. Our Evolving Atmosphere	4 – To describe the greenhouse effect. 5/6 – To explain the greenhouse effect. 7 – Justify for and against arguments for human activity affecting the greenhouse effect.	**5.9.2.1 Greenhouse gases** Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life. Water vapour, carbon dioxide and methane are greenhouse gases. Students should be able to describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter. **5.9.2.2 Human activities which contribute to an increase in greenhouse gases in the atmosphere** Some human activities increase the amounts of greenhouse gases in the atmosphere. These include: • carbon dioxide • methane. Students should be able to recall two human activities that increase the amounts of each of the greenhouse gases carbon dioxide and 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. Students should be able to: • 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. **5.9.2.3 Global climate change** An increase in average global temperature is a major cause of climate change. There are several potential effects of global climate change. Students should be able to: • describe briefly four potential effects of global climate change • discuss the scale, risk and environmental implications of global climate change.	

3. Climate Change	4 – To describe how emissions for carbon dioxide and methane can be reduced. 5 – To understand why actions to reduce greenhouse gases may be limited. 6/7 – Discuss the scale, risk and environmental implications of global climate change.	**5.9.2.4 The carbon footprint and its reduction** 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. Students should be able to: • describe actions to reduce emissions of carbon dioxide and methane • give reasons why actions may be limited.	
4. Atmospheric Pollution	4 – Give the products of combustion. 5 – To describe the problems caused by increased amounts of pollutants in the air. 6/7 – Evaluate the social, economic and environmental consequences of atmospheric pollution.	**5.9.3.1 Atmospheric pollutants from fuels** 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. Students should be able to: • 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. **5.9.3.2 Properties and effects of atmospheric pollutants** 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. Students should be able to describe and explain the problems caused by increased amounts of these pollutants in the air.	DEMO – Combustion of sulfur PRAC – Complete and incomplete combustion using Bunsen burners Equipment to order: Evaporating basins