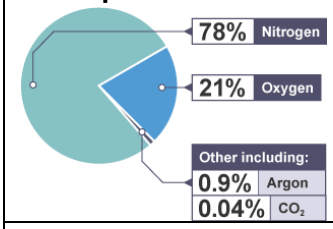
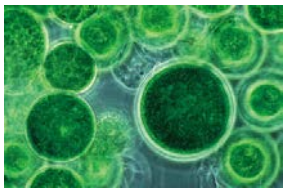
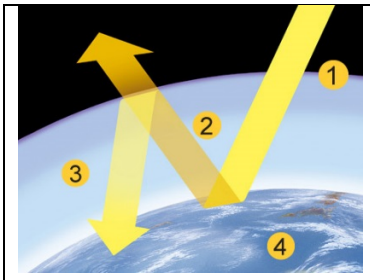
4.9 Chemistry of the atmosphere– Knowledge organiser

	The composition and evolution of the Earth's atmosphere
4.9.1.1 The proportions of 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**
4.9.1.2 The Earth's early atmosphere	Theories about the composition of the earth's early atmosphere and how it's formed has changed over time. Evidence is limited since it is thought this occurred 3.6 billion years ago. One theory suggested is below: • Billion years ago an intense volcanic activity first lead to the release of gases that formed the early atmosphere and water vapour that condensed to form the oceans • At that time, the Earth's atmosphere resembled that of Mars and Venus today, consisting mainly of carbon dioxide with little or no oxygen • Volcanoes produced nitrogen that gradually built up in the atmosphere, along with 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.
4.9.1.3 How oxygen increased 	**Algae and plants produced the oxygen** that is now in the atmosphere by photosynthesis, which can be represented by the equation: $6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$ carbon dioxide + water → glucose + oxygen (light) 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.
4.9.1.4 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** (limestone) and fossil fuels (coal, oil, natural gas) that contain carbon.
	Carbon dioxide and methane as greenhouse gases
4.9.2.1 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.

	**Greenhouse effect:** 1. The electromagnetic radiation at most wavelengths from the Sun **passes** through the Earth's atmosphere. 2. The Earth **absorbs electromagnetic radiation with short wavelengths** and so warms up. Heat is **then radiated** from the Earth as longer wavelength infrared radiation. 3. Some of this <u>infrared radiation</u> is absorbed by greenhouse gases in the atmosphere. 4. The atmosphere warms up
4.9.2.2 Human activities	Human activities **can increase the amounts of greenhouse gases (such as methane and carbon dioxide)** in the atmosphere. <u>More farming:</u> Increased farming of crops (rice, for example) and farm animals such as cattle are leading to an increase in levels of methane. <u>More landfills</u>: Garbage in landfills undergoes decay (decomposition) and releases methane (and some carbon dioxide). <u>Energy consumption:</u> Fossil fuels are being burnt to keep up with energy demands, leading to increase in levels of carbon dioxide and methane. <u>Deforestation:</u> Forests are cleared for agriculture or development, so most of the carbon in the burned trees escapes to the atmosphere
4.9.2.3 Global climate change	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. A rise of just a few degrees in world temperatures can cause **drought**, **flooding** in others, **melting of polar ice caps** leading to **raised sea levels, increased coastal destruction.**
4.9.2.4 Reducing carbon footprint	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.**
4.4.3	**Common atmospheric pollutants and their sources**
4.9.3.1 Atmospheric pollutants from fuels	The **combustion (burning)** of fuels, including coal, contain carbon and/or hydrogen and may also contain some sulfur. When burnt, these fuels release gases (**carbon dioxide, water vapour, carbon monoxide, sulfur dioxide and oxides of nitrogen**) into the atmosphere. **Solid particles and unburned hydrocarbons may also be released that form particulates in the atmosphere.** **<u>Complete combustion</u>** hydrocarbon + oxygen → carbon dioxide + water **<u>Incomplete combustion (when there is less oxygen)</u>** hydrocarbon + oxygen → carbon monoxide + carbon + water
4.9.3.2 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.