Curriculum links and Lesson Overview

Lesson	Subject	Curriculum link	Outline	Notes/ lesson outline
Themes	Science – How Science works	AQA 10.4 AQA 10.9	Experimental design Limitations of scientific data	
1	Science – Biology Science – Chemistry Env. Science	AQA 11.8 AQA 12.3 A2.3 A3	Process of Global Warming (CO_2, Methane etc) How may human activities change the climate	Practical based lesson comparing temperature rise of a standard atmosphere vs CO_2 rich atmosphere
2	Science – Chemistry	AQA 12.6	Evolution of the Earth's atmosphere	Graph producing exercise
3	Environmental Science	A3	Why is the Greenhouse effect important What are the potential effects of Global Climate change	Lesson based on examination of how climate change data is collected and need for reliable evidence
4	Environmental Science	A3	Can Global Climate change be stopped	Wiki based activity – group collaboration examining different methods of prevention

Teaching Sequence

The four lessons introduce how global warming works, then move on to show how the climate has changed over time to put changes into perspective. Lesson 3 examines how scientists gather data about climate change and finally lesson 4 examines the evidence for and against global warming.

Daniel Rose

CLIMATE CHANGE

<table>
<tr><th>Lesson 1</th><th>Activity</th><th>Notes</th></tr>
<tr><td>Objectives</td><td>Link atmospheric gases with the effects on the climate
Describe the process of global warming
Write a conclusion about the validity of your experiment as a model of climate change</td><td>A key point in this lesson is about proving the link between rising CO_2 levels and increasing temperatures.
CO_2</td></tr>
<tr><td>Entry / Settling activity</td><td>Match these pairs of words (gases to the effect they cause):

<table><tr><td>Carbon Dioxide</td><td>Global Warming</td></tr><tr><td>Sulphur Dioxide</td><td>Acid Rain</td></tr><tr><td>Nitrogen Oxide</td><td>Acid Rain</td></tr><tr><td>Methane</td><td>Global Warming</td></tr><tr><td>CFCs</td><td>Ozone layer depletion</td></tr><tr><td>Water</td><td>Rain</td></tr></table>
Relative contributions of each gas towards global warming
<table><tr><td>Water Vapor</td><td>H_2O</td><td>36 – 72 %</td></tr><tr><td>Carbon Dioxide</td><td>CO_2</td><td>9 – 26 %</td></tr><tr><td>Methane</td><td>CH_4</td><td>4 – 9 %</td></tr><tr><td>Ozone</td><td>O_3</td><td>3 – 7 %</td></tr></table></td><td>From previous teaching, students may well come up with the answers shown, however each of these gases can have several effects.
Carbon Dioxide can also produce acid rain
Methane is far more potent than Carbon dioxide in causing global warming, but due to lower emissions only causes around 1/3 of global warming.
Water also absorbs heat and contributes to global warming and has the greatest overall effect on global warming.
Nitrogen oxides can also have an effect, but it is unclear to what extent.
CFCs absorb infra red radiation and per molecule are more than 10,000 times more effective at causing global warming. In particular, they take significantly longer to degrade, so their effect lasts over a greater period of time.
http://www.lenntech.com/greenhouse-effect/greenhouse-gases.htm

It is important to be aware that this starter can introduce new misconceptions or areas of confusion.</td></tr>
<tr><td>Starter 0-10 mins</td><td>Introduce a sample of dry ice.
1 Through Q&A elicit from students that it is actually solid carbon dioxide.
2 Ask why it is solid at room temperature</td><td>Although not always easy to come by for schools, dry ice can be ordered in, or try approaching local chemical companies or universities. It is well worth getting in. Perhaps you could arrange for all teachers to teach the</td></tr>
</table>

	3 Show a small sample evaporating, ask what is special about the evaporation (sublimation) 4 Ask what form of pollution carbon dioxide is responsible for. Add a generous volume of universal indicator solution to a large (1 litre) measuring cylinder. Discuss the colour. Now add some dry ice and discuss the colour change. The dry ice has caused the water to decrease in pH and become more acidic, the effect is quite dramatic.	same lesson on a day (a climate change day). To make the most of your dry ice, see Steve Spangler Science http://www.stevespanglerscience.com/ for some great experiments. **Please check CLEAPPs for safe use of dry ice** The starter activity introduces the complexities of climate change. If you can not get any dry ice, you can use either the photos in the power point or there are some great videos on Steve Spangler Science. http://www.stevespanglerscience.com/experiment/00000055
Main 10-15 mins	Summarize starter activities and outline that climate chemistry is complex and that each gas has a number of roles. Introduce Objectives at this stage.	This practical activity allows many aspects of How Science works concepts to be taught, from planning, to data analysis and presentation. However, we find that students are more confident with these aspects. Additionally, tackling too much of a broad coverage of HSW skills leads to less progress. This activity is therefore focused on Validity, a concept students find difficult and has quite deliberately left out certain HSW elements. It also fits very well with the topic.
Practical 15-30 mins	Lots of versions of this experiment can be found on the web, however, it is the delivery that is important. Students will be measuring the temperature of air in two-three different lemonade bottles, each with different concentrations of Carbon dioxide inside them. To introduce the practical, students could be given five different coloured post it notes. On each they need to write answers to the following questions:	Ofsted praise practical activities that are short and succinct. Students should spend their time collecting data and sharing data where possible and less time in constructing practicals or performing steps that do not add to learning. This planning exercise can be developed and reviewed if this is the focus of the activity OR the five post its in the power point can be used to explain the activity.

	What will I measure? What will I keep the same? What will I change? What equipment do I need? What do I think my results will look like? **For each set students will require:** 1 lemonade bottle A small blob of plasticine (to hold the thermometer in place) A thermometer (or temperature probes and data loggers can be used). A desk lamp with a 100 watt light bulb A small piece of tinfoil If you prefer, a very detailed description can be found in the Climate change PDF document by Vicky Wong. Students should run the practical for 10 minutes. However it may be prudent to trial the activity to ensure you get a temperature change with your kit. You could add in a black back ground to half of the bottle, stick some black sugar paper to one side. Or you could print off a colour map of the world and stick this to one side.	Students may run 2-3 sets simultaneously or subsequently. To alter the CO_2 concentration, students could hold a bottle over a burning candle, blow into two or three times or add some dry ice.
Plenary part 1 30-40 mins	Students input their data on the live spread sheet (Lesson 1 Data collection sheet) excel file. This will automatically generate a graph. There is an opportunity to discuss graph type and labelling of the graph to support graph skills for course work.	I recently observed a teacher who used the "Change graph type" button to introduce the wrong graphs to students. It was very quick to change to the correct one and an excellent use of IT.
	At this point, Objective 2 can be introduced. Ask students	• There are lots of good web animations should this

	what the results have shown (hopefully the higher CO_2 content bottles will have absorbed more heat). However, it does not matter too much if ideal results are not achieved, see next section. Explain how global warming works.	link disappear. http://earthguide.ucsd.edu/earthguide/diagrams/greenhouse/
Plenary 2	The experiment has been deliberately designed not to be perfect which allows students to criticise it. Give students one post it note each. They each need to write down one reason why the experiment may not produce evidence which supports current ideas about global warming. They might consider: The very high concentrations of CO_2 (exhaled air -4%, current rise in CO_2 concentrations is around 100 ppm!). Their apparatus may have used black card as backing, but the earth's surface is mostly blue/green due to oceans.	
	Ask students to line up across room as a continuum. Students should stand at the left if they think their experiment does provide evidence, and the right if they think it does not, or somewhere in between.	
What have I learnt	Students can complete the assessment triangles to show what they have learnt. These reflect the objectives.	Assessment triangles show the progress every student has made against the lesson objectives. This is the most important aspect of an outstanding lesson.
Extension	Students could alter other aspects of the gas content of the containers. They could increase water content, fill them with methane from the gas taps (will need careful risk assessment!) or may even use aerosols.	

Lesson 2	Activity	Notes
Objectives	Create a graph that demonstrates how the Earth's atmosphere has evolved	
Entry / Settling activity 0-10 mins	This video on You tube of Myth Busters can serve as a great lesson hook http://www.youtube.com/watch?v=d-XbjFn3aqE It shows the effects of helium and also xenon. Use this to start discussion about where to get Helium from. Establish its state as a noble gas (unreactive and therefore fairly safe, unless you asphyxiate!) and then lead to its presence in the atmosphere. Finally, ask the question, has it always been in the atmosphere. Teacher notes: Noble gases were around in concentrations much higher than they are today (trace amounts – however there is around 1% Argon). Noble gases will not react with other chemicals, being inert, therefore it is believed that they were lost from the earth's atmosphere as they became heated to escape velocities and escaped the Earth's gravity.	Fun video clips can serve as great lesson hooks to engage students from the moment they walk through the door. Unfortunately not all schools or LEAs allow access to You tube in school. Three alternatives are: 1 Try www.planetscicast.co.uk which is a rapidly growing site that has some great science based clips. 2 Load up a you tube clip at home, leave your internet browser open and hibernate your laptop. It will still play when you get into work. 3 Real player sometimes allows you to save you tube videos, alternatively type in "You tuber grabber" into Google for lots of pieces of free software that can be used to save clips. Avoid installing any of the extra internet add ins that come with these files though as they can slow your computer down (e.g. My web search)
Main 10-40 mins	Task : Produce an annotated graph of changes in atmospheric gases since the earth formed. Students need to be given the two resource posters. Resource Poster 1 is available from the British Geological	This activity develops student's numerical abilities and it's a good time to make links to ISA course work (AQA) requirements for graph production.

	Survey for free, you just need to pay postage. The second poster (Resource poster 2) provides back ground information on climate change. They will also need a sheet of graph paper and a sheet of A3 paper. Students will also need a copy of the Data sheet. They should plot the tabulated data, but two other graphs have also been included and this can be used to discuss differences in sources of information. They may choose to plot the more detailed oxygen data for the last 1000 million years. However, for lower ability classes, just delete these extra graphs if they will cause confusion. Instructions for students can be displayed from the power point or printed off as work sheets. The two key parts to the work are firstly to plot the supplied data showing how relative concentrations of each gas has changed. Secondly students then need to use the information sources to annotate the graph. The student instructions give guidance or the task could be left more open.	Resource Poster 1 has lots of information on it, but it does not explicitly state the reasons for changes in gases so weaker students may need some guidance or the task modelled at the start of the lesson. The key reasons for changes are: Volcanic activity released CO_2 (particularly active seasons are shown on the time line) Photosynthetic organisms evolved which consumed CO_2 and released Oxygen Carbon Dioxide was locked up as carbonates in rocks Teacher notes: Initially, the oxygen generated by photosynthetic organisms in the Precambrian era was quickly locked up by Iron which was oxidized. It was not until the Iron had used its quota that atmospheric concentrations started to change significantly. http://www.americanchronicle.com/articles/view/105006 Possible Misconception Early bacteria evolved before any photosynthetic organisms, so students might be confused about the changes in oxygen and carbon dioxide. However, early bacteria did not use oxygen and were more like some of the extreme bacteria found around deep sea vents that use sulphur or other chemicals to generate energy.
Plenary	As a fun way to reinforce the lesson's objectives, students can be divided in to four groups. The students will need to form a human graph. This might need a bit of space and if it is easy the desks can be moved to the side. The first group will represent the axis and will need post it	An outstanding lesson (OFSTED) should assess the progress made by students. Therefore sufficient time should be given to a plenary which allows this assessment to take place. OFSTED noted that poorer lessons often have very short plenaries that are not

	notes that they can write values on. The other three groups will represent a gas each. They will need to plot themselves using the axis. They can then link up with a length of string. If you can take a picture with a digital camera and print out a copy for each student either for the end of the lesson or the next lesson's starter, students can then describe it to their partner. Alternatively, a quick walking quiz could be carried out. Use the true false questions in the power point. If students think an answer is true they go to one end of the room, if they think it is false, the other.	related to the objectives. Most students will tend to move with the crowd in this type of quiz, but spot students who hesitate or clearly follow their friends and then ask them to justify their answer. Most of the answers should be fairly obvious, however it is worth noting that coal is formed from trees whilst oil is produced from plankton.
What have I learnt	Students complete the assessment triangles which focus on key changes to the atmosphere.	
Extension	The Carbon Dioxide data was collected from Mauna Loa in a barren Volcanic island in Hawaii. Students can discuss why this is the most reliable site to gather data, compared to Britain for example.	

Lesson 3	Activity	Notes
Objectives	Evaluate the reliability of different methods of measuring climate change.	
Entry / Settling activity / Starter	Display the newspaper clip (or this could be printed and issued). It shows pictures of UFOs and is from the Sun newspaper. Through a show of hands, or movement around the room, ask students if they believe the story or not. Give small groups an A3 sheet of paper. Give them 2 minutes exactly to write down as many reasons as they can as to why this story may be unreliable. Pool these ideas on the board and add in any extras.	This lesson will rely on student's abilities to evaluate evidence, but for many evaluation skills are really hard and we often just test students with out training them first. This starter activity runs through the training aspect of evaluating evidence by using an easy and engaging idea. Students will later be much better at applying their knowledge they have gained in this starter to the next activity. The 2 minute time limit when used in lots of lessons is very good at bringing in pace to the lesson as students come to realize that they have to start quickly, especially at tasks that should be fairly straight forward and only merit a few minutes of the lesson.
Main – part 1 10-25 mins	This lesson uses an activity called "Envoys." Students need to work in groups of 5-6. Each group should be numbered. Each student should be made aware that all the students in their group share the same number at this stage. Students now need to analyse their piece of research and each make notes on the reliability of this evidence. The power point contains a frame for this discussion. It is vital that all members take a role in this activity because they will be relied on in stage 2.	
Main – part 2	In part 2, 1 member from each group will form a new group,	This activity is a very effective way of making group

25-40 mins	so that the new groups now contain members from each group. Every body in the group should have a different number. Students should now be given a tight time limit of 2-3 minutes to first explain their method and then take any questions. Students can then complete the writing frame.	work… work! All students need to be involved because they will make a contribution later. The tight time limits ensure there is little time for going off task. Its quite useful to reinforce that for at least the first 90 seconds there should only be one person talking in each group. After that time other students can ask questions.
Plenary	Using the plenary power point slide, students should come and initial on the board how reliable they think each piece of evidence is. Once all students have initialled the board for each piece of evidence, the teacher can draw their attention to where the majority of the class has signed the board. They can also use the initials to identify who has particularly extreme views and questions these students.	This method relies on classes having a data projector that projects on to a board that can be written on, but not all classes may have this. Instead you could use a blank display board or use post its on the board, or ask students to move around the room. However, my other favourite technique is to find a large desk and let students write on the table. Most board markers work equally well on the desks and are easily cleaned off (by a keen or naughty student!) and students love the fact they think they are doing something wrong. To engage some classes, I have let them make large mind maps on the desks, try it!
What have I learnt	Students complete the assessment triangles which focus on methods to measure climate change	
Extension	All of the graphs have been included, as well as the well known hockey stick graph. It might be good to point out that just because two sets of data correlate, it does not mean they are always cause and effect.	

Lesson 4	Activity	Notes
Objectives	To produce a group wiki on methods to combat global warming	This activity can be done in a number of ways from low tech to high tech. Each method is given below.
Entry / Settling activity / Starter	Display the first slide of images. Display a count down timer on the board. Give students 3 minutes to be settled, books out, written the date (leave a space for the title) and written one possible connection between each of the pictures. Bob Geldoff was famously at live 8 concert, take a bike instead of driving to work and the open jet engine is a new NASA design to massively increase efficiency of jet engines. Now you can introduce the objectives and outline the lesson.	www.classtools.net has a number of useful tools including a countdown timer you can display. You can also easily create flash quizzes that are exportable to your VLE.
Main 5-35 mins	Students can produce the collaborative project in a number of ways. However, the objective of this activity is to 1 Promote collective responsibility for group learning 2 Be able to use a range of information sources 3 Peer assess colleagues work There are two parts to this activity. The first part involves presenting a simple poster/fact sheet on 1 method to prevent global warming. The power point includes a frame work for this.	I am a great lover of IT and have found the High tech VLE method an incredibly powerful way of getting students to peer assess each others work. I set this as a home work and ask students to look at the websites of three other students and write a constructive evaluation of their work. This not only ensures that weaker students look at stronger student's work, it also develops an ability to peer assess work. Secondly, by doing this in a discussion forum, I can in class refer students to good and bad peer assessments and so develop this skill as well. However, there is a tendency that when students use the web they will cut and paste from the internet. There are two possible ways around this. The first is to produce a frame that asks students to explain what they have found (this frame is in the powerpoint (sample poster) and could be provided on a VLE to

	Low tech Each student will work on an individual poster or fact sheet on one aspect of global warming prevention. A large display board in the room should be made available in the room for this activity. Students will be presenting their information on the display board and deciding how it should be arranged. They will use post it notes to peer assess the work. **High Tech** Each student produces an individual poster (1 powerpoint slide, no animations) or a fact sheet in Word or Publisher (or equivalent). Students can then upload these to their VLE. As VLE's differ greatly, I will leave that up to the individual teacher. It may be easier to get students to make an individual web page instead. Students will use a discussion forum to peer assess each others work. **Very High Tech!** Some VLEs have a wiki feature built in, or if you if	save on the time spent on design). The second way is to get them to change the format of the work, e.g. from a long website, to a short powerpoint slide with a maximum of 50 words, so students have to summarize. Finally, many students will not enjoy hand writing out a website, so using the low tech method will encourage students to summarize rather than copy out long websites. **Possible Starting Points** http://environment.nationalgeographic.com/environment/global-warming/gw-solutions/ The IPCC – Intergovernmental panel on climate change is the central body involved in collaborating research, however as a website it is not always overly helpful for students. http://www.ipcc.ch/index.htm http://www.teachclimatechange.org.uk/ may be helpful for other activities. http://www.metoffice.gov.uk/climatechange/ - Met office also has a range of information **Alternative low tech activity** If you do not like the idea of creating a display board, or want students to be involved with more of the methods that can prevent global warming, then you could get them to create top trumps cards. Each card will need a picture and key information. I have included a template. Students can play the game as part of the plenary. **VLE** We use Uniservity which has a built in wiki tool. This is very

	have fairly unrestricted internet access you can find sites that allow you to create your own wiki. These often have "Discuss this article" type links where the students can click a different tab and leave their comments on an article. Everything else from the high tech method can be used (with regard to peer assessment) but as an added bonus it will allow the teacher to ensure that all articles are discussed and not just the first three links!	easy to use and unlike some of the other options, does not require any special settings for the students (access rights etc). However, beware that sometimes these tools are not designed for the classroom with 30 students simultaneously editing a single page. Its best to ensure there is a separate page for each student to work on.
Plenary part 1	The second part of this lesson involves the sharing of this information and peer assessment of the work. This lesson could be split into two lessons or part done as preparation at home and the second part in class. **Low tech** Now give each student 1 pink and 1 green post it note. On the green post it note, they must write the grade they feel that has been achieved (see powerpoint) plus a positive comment. On the pink post it , they must write what needs to be done next (ie use the success criteria from the next level) and another improvement. This could be a reason why they feel the next level has not been achieved, e.g. not attempted or not enough depth. They should then stick their post it notes on to the work. Give students one post it note each. Ask them to write down one way of sorting the pile of fact sheets just created by the class. For example, it	A display should not be static, but interactive, so encourage students to have some interaction with your display boards. Depending on the time available, you may want to get students to come up and rearrange the display to fit different criteria. Or it could be a quick starter in the following lesson to reinforce previous lesson's work. I like using post it notes because students are far more willing to write than in their exercise books. It also means they are not defacing other students work with them comments, so students are far more accepting of peer assessment. The colour coding is just for fun, but also provides a bit of structure so that students write a little more.

	could be – Methods that work on the left, methods that do not work on the right. Alternatively, you might like to have a continuum from left to right, this could be on cost to implement, or likelihood of success. Ask students to stick their post it notes on the white board, but they have to clump similar ideas together. The largest area of post it notes is clearly the most popular so go with that one, but you may also choose to vote or go with the most obscure. Do not let the students pin their work onto the board until they have a peer assessment stuck to it.	
High Tech plenary / HW 40-50 mins	I always set up VLE so that students post their work in a particular area. In that area I create a discussion forum with a title something like "Evaluate 3 other student's work". Students then click on the links to look at other students work before returning to the discussion forum (chat room) and they then have to leave a comment which includes the following criteria. Give the grade you think the student achieved and a reason for this. Explain what you liked and disliked about the work. Explain how you think they can develop their work by referring to the success criteria (I paste in a copy of these). This could be done in a lesson or as a home work	

	when students have more time. If its done at home, then try a moving continuum plenary. Ask students to write down on a sheet of paper in large letters, the name of the prevention method they have used. Then ask students to move to one end of the room if they strongly agree, the other end if they disagree or somewhere in the middle. Try these statements@ My method is very cheap to implement My method will have very quick results My method will be adopted easily by developed countries My method will be adopted easily by developing countries The success of my method is in dispute. You can draw students attentions to the relative positions of each and ask for a possible best method based on this information.	
What have I learnt	Students complete the assessment triangle found in the power point.	
Extension		