CLIMATE CHANGE

Country: UK

Name of the programme? GCSE SCIENCE OUTSIDE FSC – CLIMATE CHANGE

Age of the children involved?
From 14 to 16 years old.

Teaser/Short introduction
Climate change is a half day activity, part of a two night/three day residential study, where students visit an FSC (Field Studies Council) centre to study outdoor science at GCSE level.

Seen here, students from Kingsmead school using datalogging equipment to monitor the effect of Methane, Carbon dioxide, Water and carbonates on temperature rise in a model atmosphere.

What is the frame?

How scientists monitor effects of human activity on the environment, through modelling, scientific knowledge and understanding, and the process of scientific enquiry, predictions about the future of the planet can be made.

What are the goals of the programme?
To provide enrichment to support the delivery of GCSE science, building knowledge about environmental impact of human activity, and the skills of scientific enquiry, imaginative and creative thinking, problem solving and team work.

What values are promoted in the programme?
Respect for nature and respect for future generations.

Which competencies are developed?
Critical Thinking, Interpretation, Students will be able to identify connections and relationships (they will determine and report links and relationships between phenomena, events and concepts of different disciplines. They will understand the systemic nature, identifying similarities and differences, consistencies and inconsistencies, causes and effects).
Dealing with change Flexibility: Students will be able to use their sustainability linked skills and knowledge in everyday situations.
The future begins today Future, Challenge Students will develop a sense of initiative and entrepreneurship; the ability to turn ideas into action (this involves creativity, innovation and risk-taking, as well as the ability to plan and manage projects in order to achieve objectives. The individual is aware of the context of his/her work and is able to seize opportunities that arise. It is the foundation for acquiring more specific skills and knowledge needed by those establishing or contributing to social or commercial activity. This should include awareness of ethical values and promote good governance).

You & Me & All the World around us World Problems, Relationship Students will be able to recognize their relationship to nature. Having nature experiences of different kinds will encourage them to reflect on their relationship to nature.
Dealing with change Flexibility: Students will develop basic competences in science and technology. These refer to the mastery, use and application of knowledge and methodologies that explain the natural world. These involve an understanding of the changes caused
Providing the opportuntiy for action and enjoyment in real world settings, working in teams and raising curiosity through activities designed to engage the learner in a scientific problem and reveal solutions, competencies are developed such as cooperating, participating, taking responsibility and learning in a self directed way. Also, reflective and critical thinking, take ownership of learning, and enabling learners to become concious of interconnectedness.

Students seen here working out insulating properties of materials in conection with carbon footprints and reducing carbon emmissions.

Which of the specific scientific concepts does the programme relate to?

All of the scientific concepts.
Cycles: carbon cycle, water cycle, radiation reabsorption, reflection, remittance
Energy flow: Thermal radiation, Solar radiation, infrared radiation, reflection, absorption, chemical composition, heat transfer, energy transfer, photons, emission
Change and stability: Atmospheric conditions for the first billion years on Earth and the last decade. Solutions, carbon footprint,
carbon tax credits, carbon offsetting

Which of the 9 areas of Big Science Issues does the case-study relate to?

Climate change, oceanic acidification and atmospheric loading;
The importance of methane in the greenhouse effect is its warming effect. Even though it occurs in lower concentrations than carbon dioxide, it produces 21 times as much warming as CO2. Methane accounts for 20% of the 'enhanced greenhouse effect'. Methane is
generated naturally by bacteria that break down organic matter, it is found in the guts of termites and other animals and in natural gas deposits. Methane remains in the atmosphere for 11-12 years - less time than most other greenhouse gases. At present, about two thirds of global methane comes from man-made sources, such as the burning of fossil fuel, the accidental release during drilling for natural gas or from cattle ranching. Since the Industrial Revolution, the level of Methane in the atmosphere has increased by about two and a half times.

Loss of biodiversity and land system change;

Transferability: Which areas of learning are included and how?

Related to the learners themselves: using the carbon footprint it relates to the learners impact on the atmosphere
Related to the natural environment: calculating carbon absorption of a tree relates the learner to the environment locally
Related to the non-natural environment: human activity and the effects of land use change are addressed in this activity

What educational strategies are used in your programme?

The method used to deliver this prgramme was an adapted version of the Five E's Learning Cycle. There are many versions of this model, but esstentially it is a learning model that enhances the students exploration of the environment and problems to be solved, therefore it is useful in an outdoor learning environment.

Engagement	Object, event or question used to engage students. Connections facilitated between what students know and can do
Exploration	Objects and phenomena are explored. Hands-on activities, with guidance.
Explanation	Students explain their understanding of concepts and processes. New concepts and skills are introduced as conceptual clarity and cohesion are sought
Elaboration	Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

How is the programme evaluated?

All or some of the desired learning objectives can be measured for assessment depending on the desired aims of the visiting school:

The learning objectives are SMART (simple, measurable, achievable, realistic, time) and a pre and post evaluation is done to gauge learner progress:

- Engage with ecosystem of pond, woodland and agricultural field, look for the local to global cause and effect of climate change
- Be able to plan and carry out an investigation taking controls and fair tests into account
- Be able to record accurately effect of three gases on thermal radiation
- Be able to explain to peers the three causes of greenhouse gas emmissions
- Be able to explain the effect of one greenhouse gas on thermal radiation
- Be able to explain to peers two effects of increased global temperatures
- Be able to suggest one way their behaviour could change to lower carbon emmissions (all different)

These are measured during presentations by the students. During the explain, elaborate and evaluate phase, students are given a pre course list of learning objectives that they use to gauge current knowledge and again at the end to look for progress.

In each of the sessions, the teacher gives the students information about what they have done well and how they might improve their work to reach the goal. The goals maybe at the micro and reductionist level suggest as, to explain what is happening in the experiment at a molecular level or they may range into the open question end, for example, to explain to the local public why it is important to reduce carbon emissions for the local wildlife.

Key Quotes from the teachers and students.

Mr Bernie Lewis, Deputy Head: "At Kingsmead we are committed to enabling our learners to develop their knowledge and skills whilst placing equal value on fostering imaginative thinking and working in partnership."

"The opportunities and experiences at Nettlecombe have become an integral part of our enrichment programme. Through challenging and thought provoking activities the outdoor classroom gives every student a chance to get involved in something which is stimulating and enjoyable."

Tom Frost, Senior Tutor: "It was great to see the engagement in the students as they observed and participated in several different activities that demonstrated science outside. The majority of the content was new for the year 8 students but they will soon be using this experience back at school to reinforce the lessons."

The goals of the activity will depend on the groups purpose for completing the activity, as well as the ability and age range of the students.

Students will also receive feedback during the evaluation phase on their metacognition in terms of planning and processing data during the scientific enquiry. As an example, teachers may provide details on the language needed to provide a 'good' scientific report, e.g. definitions of the words such as explain, describe, analyse. Summative feedback is provided by the quality of the experimental results, whereas formative feedback is mainly orally delivered the teacher.

In addition, there are opportunities for students to provide 'peer assessment' during the explain phase, as students can comment on each other's explanation of the science behind carbon emissions. The criteria for the explanation, can be linked to providing a newspaper article or media campaign to persuade people to change their behaviour, as in the evaluation phase activity

Describe the programme

Describe the activity, learning models and methods.

This can be taught through the 5E's model

1. Engagement: The starter activity is designed to create interest and stimulate curiosity, by setting the learning within a meaningful context. Students complete calculations of the amount of carbon that they emitted to get to the centre that day. They then pick a tree and calculate the carbon that is absorbed by the tree. The activities raise questions for the inquiry and allows students to compare ideas and beliefs about the cause of carbon emissions and methane.

Students use the mind maps to help them brainstorm ideas relating to their everyday lives and the local environment they live in, looking for links into the ways in which carbon is produced and in what form. .

2. Explore: Kinaesthetic activity where students model particles in the atmosphere. This can be done using the students as the particles, making up the molecular structures. Other students have rolled up paper to represent infrared radiation emitted from the earth's surface. The students who are greenhouse gases stand in the defined atmosphere and the infrared particles are thrown. Due to their size and vibrations the 'greenhouse gas' students stop the IR from leaving the atmosphere, it is re-emitted or absorbed.

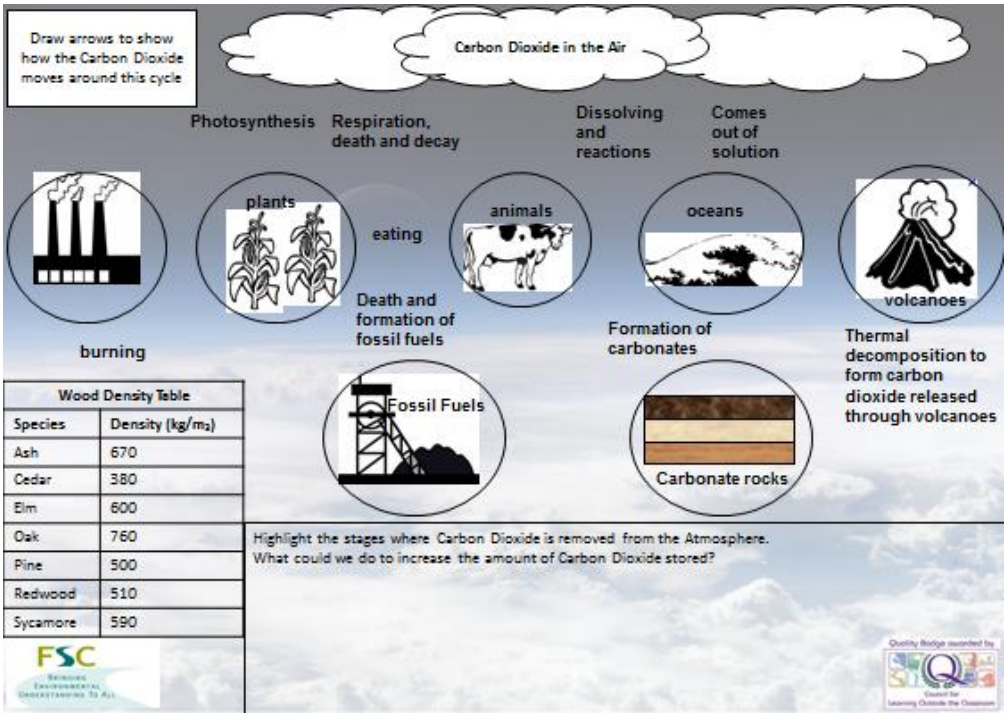
3. Explain: Students are given a selection of verbal reasoning questions to scaffold their explanations and compare these with the current scientific explanations of how carbon emissions could affect global warming, both at a local level and a global level. Time can be allowed for students to discuss this in small groups, with key terminology that will be useful in explaining the scientific background.

4. Elaborate: Students plan the experiment with the given equipment, providing an opportunity to apply, clarify, extend and consolidate the new material that they have learnt. The methane collection demonstrated and performed by staff, methane burned to show it is methane. Students set up experiment and make recordings. Additional further reading material and group writing exercises can be used, for example newspaper articles to explain the experiment and the scientific outcomes, using a range of diagrammatic and graphic modes, as well as scientific language.

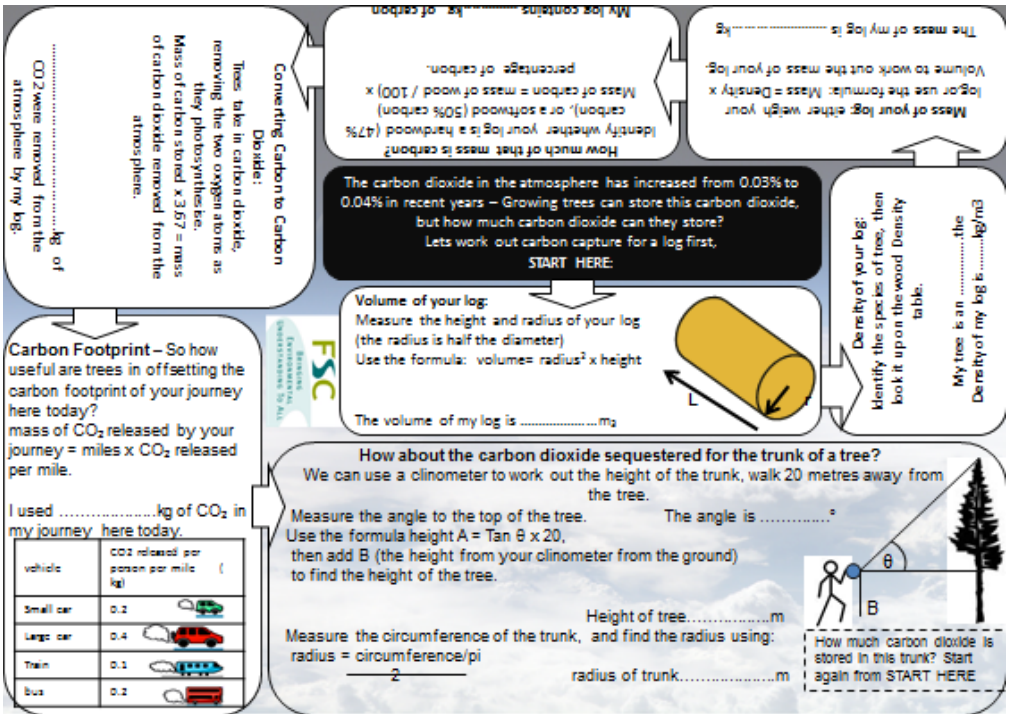
5. Evaluate: Students are given the mind map and a selection of open questions on which to prepare presentation on solutions, each person in group must come up with a different behavioural change to lower

carbon emissions. Students may complete a timeline in order to scaffold their knowledge. This allows students to reflect on their understanding of the science and how this affects
the behaviours that might arise from this understanding. A presentation to a local group of the public to illustrate this could be prepared or a media campaign planned to encourage others to change their behaviour, this would incorporate both the science and the global impact as well as the behaviour changes suggested. This phase is also a time for students to reflect on their own learning and how the sequence of tasks has improved their understanding, beliefs and skills.

Resources:



Wood Density Table	
Species	Density (kg/m$_3$)
Ash	670
Cedar	380
Elm	600
Oak	760
Pine	500
Redwood	510
Sycamore	590



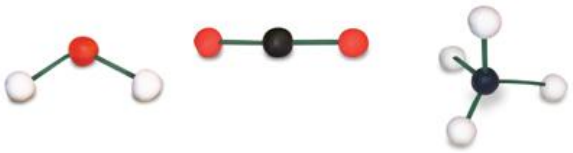
vehicle	CO2 released per person per mile (kg)
Small car	0.2
Large car	0.4
Train	0.1
Bus	0.2

Activity 2: modelling greenhouse gases

Greenhouse gases

FSC
Bringing Environmental Understanding To All

Water vapour | Carbon dioxide | Methane



What do the greenhouse gas molecules have in common?

They all have more than two atoms. They have bonds that allow the atoms to vibrate to and fro in time with heat radiation.

Building Greenhouse Gases

Worksheet on climate change and investigation

FSC
Bringing Environmental Understanding To All

CLIMATE CHANGE

Quality Badge awarded by SIQ Council for Learning Outside the Classroom

INVESTIGATIONS INTO THE ATMOSPHERE.
HOW HUMAN ACTIVITY HAS AFFECTED IT AND SOLUTIONS

Preparation of the gases: Into bottles you can add any of or all of the following:

CO_2	Mix **vinegar** and **sodium bicarbonate**
WATER VAPOUR	Water
SMOKE	Light 3 leaves collect smoke in upturned bottle
CH_4	Teacher assistance
CONTROL	
YOUR IDEAS	

Place the bottles with the gases and thermometers in the sun

Record initial temp and increase in temp over time

STOP THINK! What are your independent and dependent variables? What things do you need to keep the same? What do you need to do to make sure it is not just the bottle heating the atmosphere?

BACKGROUND INFO

Sodium bicarbonate reacts with acetic acid (found in vinegar), producing sodium acetate, water, and carbon dioxide: $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$

Calculate the volume of CO_2 gas produced from 1g of sodium bicarbonate in excess acetic acid:

PREDICTION

Can you use the molecule models that you built in investigation 1 to make and explain a prediction:

CLIMATE CHANGE

INVESTIGATIONS INTO THE ATMOSPHERE.
HOW HUMAN ACTIVITY HAS AFFECTED IT AND SOLUTIONS

You are given four suggested investigations and a variety of materials.

You will design and carry out these investigation.

Working scientifically, using your workbook to guide you.
Collect reliable data, process the data to reach valid conclusions, and evaluate your procedure.

INVESTIGATION 1: MODELLING THE ATMOSPHERE

AIM: To explain what the atmosphere looked like when the planet formed, how it has changed over millions of years, and recent changes in the last 100 years due to human activity.

Use the power point and equipment from your box to create model molecules.

USE THIS SHEET AS A GUIDE

What is climate change?
Definition of Climate Change =

Atmosphere facts

- The air is made up of
- This mixture has stayed fairly constant for the last_____million years.

Gas	Formula	% dry air	What do they look like?
Nitrogen			
Oxygen			
Argon	Ar		
Carbon dioxide			
Other gases		Traces	

The amount of water vapour changes due to changes in the _____, this is why it's not included when giving the composition of air.

What is the green house effect and what gases contribute to this?

What would the earths temperature be without these gases? _____

Which gas has about 25 times global warming potential of Carbon Dioxide? _____

INVESTIGATION 2: MONITORING THE EFFECTS OF A VARIETY OF GASES AND SOLIDS PRODUCED BY HUMAN ACTIVITY ON THERMAL RADIATION IN A MODEL ATMOSPHERE.

AIM: To measure the effect of atmospheric loading of a variety of gases and solids on infrared radiation measured as a temperature change