Teacher Guide
CO_2 What Does it Mean To You

This lesson is a hands on introduction to the Chemistry of Climate Change. This lesson is designed using the 3 dimensions from the Framework for K-12 Science Education to align with the Next Generation Science Standards. In this lesson students will be engaged in several of the science and engineering practices (SEPs) and their thinking guided by questions and prompts using the crosscutting concepts (CCCs). This lesson was designed to have students engage with the phenomenon of the cycling of Carbon Dioxide in our environment, to explore the Carbon Cycle and the effects carbon dioxide gas has on the environment.

This lesson can fit in a variety of contexts within a chemistry curriculum. It could introduce a unit on Climate and Climate Change. It could also fit within a lesson on heat and energy transfer or as a phenomenon for a lesson on stoichiometry as related calculations could involve quantities of CO_2 gas.

In this lesson students will complete 4 activities.

Activity 1: Students will generate questions from a video phenomenon
Activity 2: Students will begin development of a model of the carbon cycle
Activity 3: Students will evaluate and refine the model of the carbon cycle
Activity 4: Students will analyze and interpret data provided from an experiment illustrating the effects of CO_2 on atmospheric temperatures

Activity 1: Teacher should show Segment 1 of BLOSSOMS video lesson during which students watch NASA video. After watching NASA video:

Because it is difficult to see the key in the NASA video, teacher should clarify to students that the red and purple represent carbon dioxide, while the white represents carbon monoxide.
Have students turn to a partner and construct questions.
Teacher should observe student conversations and facilitate student questioning, using prompts such as:
What patterns did you notice when you watched the NASA video?
From what areas did the CO_2 seem to be generated?
What could be some of the causes of the patterns you see?
Why do the CO values appear to change over time?

Activity 2: Occurs after Segment 2 of BLOSSOMS video lesson.
Prior to this activity, teacher should pre-print the following
1 copy of the carbon cycle process signs
1 copy of the carbon cycle product signs
A copy of the Student carbon cycle model for each student
A copy of the teacher carbon cycle answer key

The teacher should facilitate a space where the Carbon cycle process signs can be spread out in a shape similar to the shape in the Student Carbon cycle model. Suggestions of spaces could be on

desks in a classroom, on the classroom floor after moving the desks out of the way, a hallway space or a gym if available.

Prior to the activity, teacher should obtain the following materials to be used as the Carbon Cycle products in order for students to generate the model.

A stoppered test tube, labelled 'Atmosphere'
Grass or leaf (or a picture)
Hand mirror
Bag of soil
Test-tube of water labelled 'seawater'
Sea shells
Coal
A stoppered, labelled test tube of motor oil
Limestone

To begin activity 2, the teacher should divide the students into 4 groups and each group should receive two of the products listed above. One group will receive 3 products.
The students will read the signs spread throughout the space, and make a decision for which product sign makes the most sense with the item in their hand. They will assign their product to that sign. If there are any students who feel that two products fit on the same sign, the class will ask clarifying questions to make a determination as to which sign is the best fit for each product. Once the teacher has verified the decisions, the teacher will instruct the students to annotate their models.

Activity 3
After the students have watched Segment 3 of the BLOSSOMS video lesson, the groups of students should receive the Carbon Cycle Process Cards. These cards will be used to refine the model, linking separate products through a transformation process.

Each group is to receive 4 processes. The students will follow a similar procedure, evaluating the model and determining which process links two of the products. If there are any students who feel that two processes link the same products, the class will ask clarifying questions to make a determination as to which process is the best fit. Once the teacher has verified the decisions, the teacher will instruct the students to annotate their models.

Activity 4
Prior to this activity, students will have watched Segment 4 of the BLOSSOMS video lesson to observe the phenomena of a CO_2 rich environment retaining more heat energy than an environment with less CO_2.

The teacher should provide the students copies of the data collected in this activity.
Students will analyze this data by creating a graph of temperature vs time. Students can do this either digitally or on paper.
While students are generating graphs, the teacher can be prompting the analysis with questions such as:

What patterns do you notice in your graphs?
How do the patterns in the graphs compare to each other?
Is there any data that does not fit within the pattern?
Describe how the systems differ in the model and how the components would affect the system.
How is the data on the graph related to the flow of energy in the model?
How might this data set change when the scale of the model is not a small soda bottle, but instead the earth?

I hope that after completing this lesson students are familiar with the ways in which carbon moves through our environment and have some personal connection to the impact that an increased concentration of CO_2 can have on air temperature. My goal is to spark student interest and hopefully encourage your students to ask and investigate more questions about climate.