



BLOSSOMS NGSS LESSON

Target Grade: High School	Lesson Title: CO₂: Find Out What It Means to You!
Topic: Chemistry	Developed by: Erin Woulfe East Greenwich High School East Greenwich, Rhode Island
State Standard – NGSS Performance Expectation(s) HS-ESS2-6 - Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]	
Lesson Performance Expectations	
<i>Lesson Length – One 50 - 55-minute class period Lesson can be modified accordingly</i>	
Materials <ul style="list-style-type: none"> • Carbon Cycle Model Blank • Carbon Cycle Model with answers (PDF) • Carbon Cycle Process Signs (PDF) • Carbon Cycle Product Signs (PDF) • Data Blossoms Experiment - Activity4 (PDF) • Graph Paper (or have the students use Excel or other graphing software) • Poster Paper (optional) 	



BLOSSOMS NGSS LESSON

Lesson Objectives (main ideas):

- How is carbon dioxide introduced and removed into and out of the Earth's atmospheric system?
- How can we know whether the **patterns** observed are just the natural cycles of matter on Earth or whether these **patterns** of carbon dioxide concentrations are abnormal in some sense?
- What **effect** does increased carbon dioxide have on weather or climate?

Phenomenon

CO₂ is a greenhouse gas that prevents energy from escaping the Earth's atmosphere.

[Gather Phase](#)

What Is the Teacher Doing?

The concept for this lesson is an important one as all students live on a planet that is experiencing changes in temperature and weather patterns. Over time, these changes could impact overall changes in climate. Changes in climate would have an impact on recreation, agriculture and economic development. Climate change is a huge concept and, while it may seem to be beyond a student's purview, increasing student awareness of and connections to climate change will provide greater recognition of ways to mitigate the problem.

What are the Students (Ss) Doing?

The students watch the first segment (**0:00 – 4:05**) of the BLOSSOMS video. From **0:55 – 4:05** of the first segment, students will watch a NASA video depicting a supercomputer model of CO₂ and CO movement in the atmosphere during a one-year period.

BLOSSOMS NGSS LESSON

In the Classroom (Teacher):

Teacher should pause the video at the **4:05** mark of the video. Teacher should encourage students to share their observations and questions with a partner. Teacher facilitates an all-class discussion where students share their observations and questions. Teacher should record the student questions on a white board or poster paper.

Teachers should “look for” evidence of the following when students are using the practice of **Asking Questions**.

Evidence Bullets (Look Fors):

- pose questions that are testable
- formulate testable hypotheses and pose questions in science that seek evidence relevant to the question
- ask questions that require relevant empirical evidence

ask questions to determine relationships between independent and dependent variables.

From **4:07 – 5:47** of the BLOSSOMS video the video teacher shares some of her questions such as:

- How is carbon dioxide introduced and removed into and out of the Earth’s atmospheric system?
- How can we know whether the **patterns** observed are just the natural cycles of matter on Earth or whether these **patterns** of carbon dioxide concentrations are abnormal in some sense?
- What **effect** does increased carbon dioxide have on weather or climate?

These questions should parallel some of the questions that the students have generated and shared during the whole class discussion.

The teacher should pause the BLOSSOMS video at the **5:45** mark and hand out materials. (NOTE: This can be done in a classroom setting however a large empty space like a hallway, gym, or classroom with desks pushed aside might be valuable for building the large cycle. The [Carbon Cycle Product Signs](#)

could also be placed on top of desks if necessary. With the video paused at the **5:45** mark, the teacher will divide students into small groups of 2 -3 students. Each group/class will receive a set of [Carbon Cycle Product Signs](#) and [Carbon Cycle Process Signs](#) along with a [Carbon Cycle Model Blank](#)

In the Classroom (Students):

At the end of the first video segment, students are asked to discuss any observations and **questions** (see evidence bullets in the teacher column) with a partner relevant to the video. After discussing with their partner, the students should share their questions and observations with the entire class.

The video resumes at the **4:07** mark. The video teacher shares some of her questions:

- How is carbon dioxide introduced and removed into and out of the Earth’s atmospheric system?
- How can we know whether the **patterns** observed are just the natural cycles of matter on Earth or whether these **patterns** of carbon dioxide concentrations are abnormal in some sense?
- What **effect** does increased carbon dioxide have on weather or climate?

At the **5:45** point of the video the video teacher pauses the following prompt:

- Decide with your group which part of the process your samples represent. Then begin to develop your carbon cycle models.

The teacher provides student groups with the following:

- [Carbon Cycle Model Blank](#)
- [Carbon Cycle Process Signs](#)
- [Carbon Cycle Product Signs](#)

Students use the [Carbon Cycle Product Signs](#) and the [Carbon Cycle Process Signs](#) to create a **model** t(see



BLOSSOMS NGSS LESSON

[Reason Phase](#)

BLOSSOMS NGSS LESSON

In the Classroom (Teacher):

At the **5:55** point the teacher resumes the video and discusses some of the processes and how CO₂ enters into and exists from our atmosphere. At the **7:09** mark the video teacher prompts the students to:

- Evaluate and refine your models to show what **causes** CO₂ to move into and out of the atmosphere.

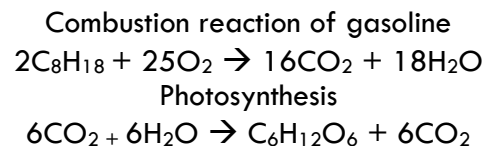
Teacher should emphasize that students are looking for possible **causes** of CO₂ moving into and out of our atmosphere. Once the groups have finished, teacher then asks students to share their **models** and **causes** for CO₂ movement as a whole class. This portion of the lesson should take **12 minutes**.

Teachers should “look for” evidence of the following when students are using the practice of **Arguing from Evidence**:

Evidence Bullets (Look Fors):

- Use models to understand arguments
- Use evidence to generate or support explanations
- Reflect on the best evidence supporting an explanation
- Listen and make sense of other’s explanations
- Evaluate and share weaknesses in one’s own arguments and collaborate to seek better evidence.

Resuming the video at the **7:10** mark, the video teacher then relates sources and absorbers of CO₂ sharing the following reactions:



The video teacher also shares the Monthly Mean CO₂ Graph from Mauna Loa Observatory. She also asks the question, “How does an increased concentration of CO₂ **effect** atmospheric temperature?”.

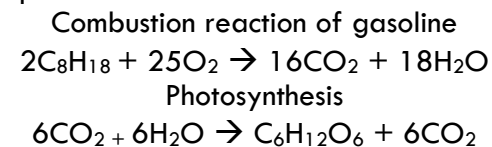
The classroom teacher may want to write the reaction equations and the question on a white board or

In the Classroom (Students):

Students observe the video from **5:55 to 7:09**. At the **7:09** mark the video teacher prompts the students to:

- Evaluate and refine your models to show what **causes** CO₂ to move into and out of the atmosphere.
- Student groups revise their models showing possible **causes** of CO₂ moving into and out of our **system** into and out of the atmosphere.
- Students then share their **models** and **causes** for CO₂ movement as a whole class using **evidence** (see evidence bullets in the teacher column) from their **models** to support their claims.

Once the video resumes the students are exposed to two reaction equations:



They are also challenged with a question from the video teacher:

“How does an increased concentration of CO₂ **effect** atmospheric temperature?”. The students then observe an experimental setup to test the question posed.

- At the 11:24 mark the video is paused and the students are asked:
Turn to a partner and make a prediction about what will happen in the model when the heat lamps are turned on.



BLOSSOMS NGSS LESSON

Communicate Phase

BLOSSOMS NGSS LESSON

In the Classroom (Teacher):

The classroom teacher then resumes the video. The video teacher begins the demonstration. At the **11:56** mark the video teacher asks students to:

- Create a **graph** and **analyze and interpret** the data from the demonstration.

The teacher hands out the [Data Blossoms Experiment - Activity4](#). This activity should take **10 minutes**

Teacher should “look for” evidence of the following when students are engaged in the practice of **Using Mathematical and Computational Thinking such as:**

- Make and use measurements as evidence.
- Compare evidence from measurements.
- Organize and analyze simple data sets for patterns that suggest relationships.
- Use graphs to find patterns and/or relationships in data.

Teacher should “look for” evidence of the following when students are engaged in the practice of **Analyzing and Interpreting Data** such as:

- Compare data to make sense of and explain phenomena.
- Compare data and use comparisons as evidence.
- Use graphical displays to analyze data in order to identify linear and nonlinear relationships.

Teachers should “look for” evidence of the following when students are using the practice of **Arguing from Evidence:**

Evidence Bullets (Look Fors):

- Use models to understand arguments
- Use evidence to generate or support explanations
- Reflect on the best evidence supporting an explanation
- Listen and make sense of other’s explanations
- Evaluate and share weaknesses in one’s own arguments and collaborate to seek better evidence.

In the Classroom (Students):

The students then observe the resumed video and watch the demonstration in progress.

- At the **11:56** mark the video teacher asks students to: Create a **graph** and **analyze and interpret** the data from the demonstration.
- The classroom hands out, to each group, the [Data Blossoms Experiment - Activity4](#)
- Student groups create a **graph** (see evidence bullets in the teacher column) of the data.
- Student groups then **analyze and interpret** (see evidence bullets in the teacher column) the data from the demonstration looking for **patterns** and possible **causes** for the **patterns** in their **graphs**.
- Once finished student groups share out their analyses and provide explanations for **causes** for the **patterns** as a whole class. Groups then **argue from the evidence** (see evidence bullets in the teacher column) in their data to support their explanations.

At the **12:05** mark the BLOSSOMS video is resumed. Students observe the video teacher’s findings from her experiment and relates some of the possible impacts of climate change over time.



BLOSSOMS NGSS LESSON

The Gather, Reason, and Communicate Performance Sequence (Moulding & Bybee, 2017)

Gather	Students are provided with a relevant phenomenon or problem that acts as the launching point for them to (1) obtain information by asking questions and defining problems for causes of the phenomenon within and among systems; (2) investigate the interactions of components of systems to determine the changes in terms of flow of energy and cycling of matter; and (3) determine the proportion of components in systems and interactions/feedback among systems. Gathering may include reading, listening, investigating, and using models.
Reason	Students use information they gathered to make sense of phenomena. Reasoning includes analyzing data and information, constructing explanations for the causes(s) of the phenomenon, engineering solutions to problems, and developing arguments for how the evidence supports or refutes explanations or solutions. Reasoning occurs in our brains, but may utilize models, speaking, and writing to organize the relationship between the causes of phenomena and the evidence supporting the explanations.
Communicate	Students communicate their reasoning by developing arguments for how evidence supports explanations. Communicating includes speaking, writing, and/or models to present explanations and arguments to themselves and others.

Moulding, B. & Bybee, R. (2017). *Teaching Science is Phenomenal*. ELM Tree Publishing: Washington, UT. ISBN:978-0-8890674-0-6