

Lesson Plan: Teaching Chemistry of Carbon Compounds through Climate-related Examples

As a **high school Chemistry** teacher, you can use this set of computer-based tools to help you in teaching **the chemistry of carbon and its compounds, the interaction of greenhouse gas molecules with electromagnetic radiation, and environmental chemistry.**

This lesson plan allows students to visualize the molecular structure of atmospheric gases and to understand the effect of electromagnetic radiation on these molecules. The activity will also introduce the topic of greenhouse gases and their role in climate change.

Thus, the use of this Lesson Plan allows you to integrate the teaching of a climate science topic with a core topic in Chemistry.

Use this lesson plan to help your students find answers to:

- *How do molecules of gases interact with electromagnetic radiation?*
- *How do atmospheric carbon dioxide (CO₂) molecules interact with infrared photons?*
- *What is the greenhouse effect of Earth's atmosphere?*
- *Could an increase in methane emissions affect the Earth's temperature? Why?*

About the Lesson Plan

Grade Level	High school
Discipline	Chemistry
Topic(s) in Discipline	Interaction of Molecules with Electromagnetic Radiation, Molecular Vibrations, Molecular Structure of Carbon Compounds (CO ₂ , CH ₄), Greenhouse Gases

Climate Topic The Greenhouse Effect, Climate and the Atmosphere

Location Global

Access Online

Language(s) This Lesson Plan is available in multiple languages

Link here: <https://tropicsu.org/resources/lesson-plans/trop-icsu-in-different-languages/>

Approximate Time Required 100–120 min

1 Contents

- 1. Reading (5–10 min)** A reading that provides an overview of the interaction between infrared radiation and molecules of different atmospheric gases.
<https://scied.ucar.edu/carbon-dioxide-absorbs-and-re-emits-infrared-radiation>
- 2. Micro-lecture (~8 min)** A micro-lecture (video) that explains the interaction of molecules such as CO₂ and CH₄ with electromagnetic radiation, and the resulting molecular vibrations leading to the greenhouse effect in the atmosphere.
<https://www.coursera.org/lecture/global-warming/greenhouse-gas-physics-SvfZD>
- 3. Visualization and associated activity (45-60)** A visualization and associated activity to observe, understand, explore and analyze the molecular structure of carbon compounds (CO₂, CH₄), the effect of electromagnetic radiation on the molecules, and the role of

min)

greenhouse gases in climate change.

<https://phet.colorado.edu/en/simulation/greenhouse>

4. Suggested questions/assignments for learning evaluation

- *How do molecules of gases interact with electromagnetic radiation?*
- *How do atmospheric carbon dioxide (CO₂) molecules interact with infrared photons?*
- *What is the greenhouse effect of Earth's atmosphere?*
- *Could an increase in methane emissions affect the Earth's temperature? Why?*

2 Step-by-step User Guide



Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. Introduce the topic through online reading

- Discuss the sources of carbon and its compounds.
- Discuss the molecular structure of some carbon compounds such as carbon dioxide (CO₂) and methane (CH₄).
- Introduce the topic of atmosphere and its composition. Name the atmospheric gases (including CO₂ and CH₄) and their typical percentages.
- Discuss the phenomenon of sunlight striking the Earth and infrared radiation being emitted from the Earth.
- Use online reading material to provide an overview of how CO₂ and other atmospheric gas molecules interact with electromagnetic radiation.

The reading material is available at: <https://scied.ucar.edu/carbon-dioxide-absorbs-and-re-emits-infrared-radiation>.

2. Play a micro-lecture (video)

Now play this micro-lecture (video, approx. 8 min) to explain the interaction of molecules such as CO₂ with electromagnetic radiation, and the resulting molecular vibrations that lead to the greenhouse effect in the atmosphere.

The video micro-lecture from David Archer, the University of Chicago, is available at: <https://www.coursera.org/lecture/global-warming/greenhouse-gas-physics-SvfZD>

3. Conduct an activity using an interactive visualization

Next, explore this topic in an interactive and engaging manner by using a visualization tool, “[The Greenhouse Effect](#)”, from PhET.

The tool will help your students to visualize the molecular structure of carbon compounds (CO₂, CH₄), explore the effect of electromagnetic radiation on the molecules, and understand the role of greenhouse gases in climate change.

- Download PhET’s tool, “The Greenhouse Effect”, from <https://phet.colorado.edu/en/simulation/greenhouse>.
- Launch the tool.
- Go to the Photon Absorption pane.
- For each Atmospheric Gas (select options under Atmospheric Gases)—CH₄, CO₂, H₂O, N₂, O₂—observe the molecular structure and the effect of the Infrared Photon on the molecule. The slider on the Light Source can be adjusted to control the rate of emission of photons.
- Use the Build Atmosphere option to set the number of molecules of each atmospheric gas.

Visualize the effect of the Infrared Photons on the molecules in the atmosphere.

- The absorption of infrared photons by gases such as CO₂ and CH₄ in the atmosphere results in the warming of the surface of the planet. This effect is called the greenhouse effect.
- Go to the Greenhouse Effect pane.
- Select different scenarios (Atmosphere during...), observe the Greenhouse Gas Composition for each scenario, and the corresponding surface temperature shown in the thermometer on the left. Draw inferences.

4. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- *How do molecules of gases interact with electromagnetic radiation?*
- *How do atmospheric carbon dioxide (CO₂) molecules interact with infrared photons?*
- *What is the greenhouse effect of Earth's atmosphere?*
- *Could an increase in methane emissions affect the Earth's temperature? Why?*

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- visualize the molecular structure of atmospheric gases
- describe the effect of electromagnetic radiation on these molecules
- identify greenhouse gases and examine their role in climate change

4 Additional Resources



If you or your students would like to explore the topic further, these additional resources will be useful.

1. Video

A video in which Iain Stewart demonstrates infrared radiation absorption by CO₂ in a scene from BBC's "Earth: The Climate Wars" documentary:

<https://www.youtube.com/watch?v=kGaV3PiobYk>

2. Visualization

An interactive visualization tool, "Greenhouse Gases", from Concord Consortium's Innovative Technology in Science Inquiry:

<https://concord.org/stem-resources/greenhouse-gases>

3. Reading

Reading material from UCAR:

https://www.ucar.edu/learn/1_3_1.htm

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided.

We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. Reading, “Carbon Dioxide Absorbs and Re-emits Infrared Radiation”

[UCAR Center for Science Education](#)

2. Micro-lecture (video)

[David Archer, the University of Chicago](#)

3. Additional Resources

Iain Stewart;

[Concord Consortium](#);

[UCAR Center for Science Education](#)