

Details



Completion Time: More than a week

Permission: Download, Share, and Remix

Greenhouse Gases/Climate Change Research Paper

Overview

There is so much media hype and public misunderstanding regarding the issue of climate change that advanced students need to be equipped to sort through the information available, find data from appropriately moderated scientific data bases, and learn to support their views with good scientific evidence rather than emotion. This lesson provides the outline for giving students some preliminary background information, having them work with the University of Colorado's interactive PhET simulation on greenhouse gases. They will watch several selected videos to develop a broader perspective of the issues, use scientific databases to collect evidence, and write a research paper.

Objectives

Students will learn:

- to read and annotate a scientific article on greenhouse gases.
- to search scientific databases for support articles.
- to write a research paper on greenhouse gases or climate change, including citing their sources correctly.

Lesson Preparation

Read the supplementary information in handout (attached).

Procedure

See attached handout

Extension

Students could research the other topics specific to the effects of climate change on polar regions.

Resources

n/a

Materials

- Handouts (attached)
- Access to computers/computer lab



Assessment

A possible grading rubric is attached in the handout.

Credits

Instructions and development of this lesson was a collaboration of Mary Bartholomew, Cheryl Paricio, and Mark Paricio (mparicio@cherrycreekschools.org)



National Science Education Standards (NSES)

Content Standards, Grades 9-12

Content Standard A: Science As Inquiry

- a. Abilities necessary to do scientific inquiry
- b. Understandings about scientific inquiry

Content Standard B: Physical Science

- f. Interactions of energy and matter

Content Standard D: Earth and Space Science

- a. Energy in the earth system
- b. Geochemical cycles

Content Standard F: Science In Personal and Social Perspectives

- d. Environmental quality
- e. Natural and human-induced hazards
- f. Science and technology in local, national, and global challenges

Other Standards

Colorado Science Standards:

21st Century Skills and Readiness Competencies in Science

Colorado's Description of 21st Century Skills:

Colorado's description of 21st century skills is a synthesis of the essential abilities students must apply in our rapidly changing world. Today's students need a repertoire of knowledge and skills that are more diverse, complex, and integrated than any previous generation. These skills do not stand alone in the standards, but are woven into the evidence outcomes, inquiry questions, and application and are within the nature of science. Science inherently demonstrates each of Colorado's 21st century skills, as follows:

Critical Thinking and Reasoning

Science requires students to analyze evidence and draw conclusions based on that evidence. Scientific investigation involves defining problems and designing studies to test hypotheses related to those problems. In science, students must justify and defend scientific explanations and distinguish between correlation and causation.

Information Literacy

Understanding science requires students to research current ideas about the natural world. Students must be able to distinguish fact from opinion and truth from fantasy. Science requires a degree of skepticism because the ideas of science are subject to change. Science students must be able to understand what constitutes reliable sources of information and how to validate those sources. One key to science is understanding that converging different lines of evidence from multiple sources strengthens a scientific conclusion.

Handout#1: Greenhouse Effect/Climate Change Research Paper

Think about a cool autumn or spring day when the sun's been shining! While there is a mild temperature outside, you get in your car that has been sitting in the sun all day, and it is HOT! Why is it so much warmer in your car than it is outside? Exploring the Greenhouse Effect will help you answer this question.

In Class:

1. Explore (play with!) the PhET simulation on Greenhouse gases to get a **conceptual** understanding of the factors involved in the Greenhouse Effect. Answer the PhET question sheet based off of the simulation to ensure you have connected the major points. <http://phet.colorado.edu/en/simulation/greenhouse>

2. Read and annotate the background information on the Greenhouse Effect in your text.

(Teacher Note: If you have a good new text, it will have new information on climate change. One such text is: Brown, Catrin, and Mike Ford. *Chemistry: standard level: developed specifically for the IB diploma*. Harlow, Essex: Pearson Education, 2008. p. 380-383. If your text does not, substitute reading from the EPA's site, *A Student's Guide to Global Climate Change*, (<http://epa.gov/climatestudents/index.html>). This site could be the basis of a lesson for younger students, but has a good amount of introductory information. For older students, use the more advanced <http://www.epa.gov/climatechange/basics/> portion of the EPA's site, as referenced in #4 below)

3. Watch the video clip(s) provided:

A. Introduction: [Climate Change at the Doorstep](#) - The city of Norfolk, Virginia, is already experiencing the effects of sea-level rise. Streets that used to flood only occasionally now fill with sea-water every time there's a full-moon. Need to Know reports on how one American city is dealing with a problem that may soon be on all our doorsteps. (11:35) <http://video.pbs.org/video/1818412519/>

B. Global Warming: [The Physics of the Greenhouse Effect](#) ("Global Warming: The Physics of the Greenhouse Effect" Teachers' Domain. 20 Feb. 2004. Web. 5 May. 2013.) <http://www.teachersdomain.org/resource/phy03.sci.phys.matter.greenhouse2/>

C. [Climate and evolution](#) (4 min) . http://www.teachersdomain.org/asset/clim10_vid_evoclimate/ Adapted from NOVA: "Becoming Human, Part 1: First Steps". Third party material courtesy of Lamont Doherty Earth Observatory, University of Potsdam, and Vigdis Broch-Due.

D. Biotechnology - This video produced by *Teacher's Domain*, http://www.teachersdomain.org/asset/biot09_vid_drennan/ features Cathy Drennan, Professor of Chemistry and Biology at the Massachusetts Institute of Technology. Cathy explains that her research focuses on microorganisms that live off carbon dioxide, one of several greenhouse gases that are widely believed to accelerate global warming. Specifically, Cathy is investigating how a protein inside these microorganisms converts carbon dioxide into energy. Ultimately, Cathy hopes humans might apply what they learn from microorganisms to remove carbon dioxide from the environment. (2.5 min)

E. To learn more about evidence of regular, extreme climate change throughout Earth's distant past, check out [Climate Change](#) (<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.climatechange/>), [Greenland Ice Sheet Project 2: A Record of Climate Change](#) (<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.greenland/>), and Natural Climate Change in Djibouti, Africa (<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.naturalchange/>).

F. To learn more about the role CO₂ plays in Earth's temperature, check out [Global Warming: Carbon Dioxide and the Greenhouse Effect](#) (<http://www.teachersdomain.org/resource/phy03.sci.ess.watcyc.co2/http://www.teachersdomain.org/resource/phy03.sci.ess.watcyc.co2/>)

G. To learn more about evidence suggesting a link between human activities and global warming, check out [CO₂ Concentrations at Mauna Loa Observatory, Hawai'i](#) (<http://www.teachersdomain.org/resource/ess05.sci.ess.watcyc.maunaloadata/>) and [Earth System: Ice and Global Warming](#) (<http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.esglaciers/>)

H. [Permafrost: The Tipping Time Bomb](#) (<http://www.youtube.com/watch?v=FLCgybStZ4g>) (6 min) Explores how increased temperatures, causing the permafrost to melt, will release CO₂ into the atmosphere.

4. Begin investigating sources for a short research paper on climate change related to global warming by greenhouse gases. Choose a specific aspect of this topic that is of interest to you. First go to www.epa.gov and select Climate Change. You will find additional articles that you can use as resources for your paper.

5. In your bound notebook, define the following vocabulary terms to aid in your understanding:
 - a. Greenhouse factor/warming potential
 - b. Anthropogenic
 - c. Relative abundance
 - d. Infrared radiation
 - e. Visible light
 - f. Ultraviolet radiation
 - g. Radiate
 - h. Absorb
 - i. Heat transfer by radiation
 - j. Heat transfer by conduction
 - k. Heat transfer by convection

On Your Own:

You are required to write a short research paper (approximately 3-5 double spaced pages in length) on a specific aspect (of your choosing) on climate change related to global warming by greenhouse gases. You must use 3-5 outside sources, and you will be required to evaluate your sources, so be sure to use a variety from print and online. Please use the MLA format for your bibliography.

Narrow your research topic by making it more specific. You have been given some background information, now brainstorm 3-5 possible areas that interest you. (For example, sea level rising, changes in industrial production of carbon dioxide over time, deforestation of the rainforests, etc...) Choose **ONE** research topic after you have completed your initial research. Find 2-3 additional resources related to the specific aspect you have chosen, and write a specific research *question* related to your topic. Find data that helps to answer the question. Include a data table and graph of the data at the back of your paper (in the appendix) and refer to the data/graph within the text of your paper. Your table/graph should have a caption included with it that describes the concept it is supporting.

The beginning of your paper will include an introduction that demonstrates your understanding of the fundamentals behind the Greenhouse effect. Include as many of the vocabulary terms from your class work (#5 above) that make sense to describe the science. **Don't** just list and define them in your paper! You should write connected sentences and paragraphs that demonstrate that you understand the science related to this issue. Use the following statements to guide your research and the introduction of your paper.

- Describe the greenhouse effect in terms of radiation of different energy and wavelengths.
- Identify the major greenhouse gases. State the main natural and man-made sources of these gases.
- Explain why carbon dioxide or methane could each be described as a more important greenhouse gas.
- Discuss the general effects of global warming on the Earth.
- Transition your paper to your specific aspect of Climate Change related to Global Warming by Greenhouse Gases.

If you need support to write a research paper, choose the link "Help writing a research paper from Rutgers University" (http://www.libraries.rutgers.edu/rul/lib_instruct/riot/). There are bonus points available for printing a certificate that indicates the specific modules that you complete to prepare to write this paper. You can choose to do the modules that will help you most. There are five different modules (Selecting a Topic, Finding Sources, Selecting Keywords, Identifying Citations and Evaluating Sources) that take approximately 5 minutes each to watch.

Your sources should come from sites included in the scientific databases to which the school subscribes. Talk to the media specialist if you do not know how to find them.

Checklist for Paper

- Cover Page (Research Question as Title, Name, Period, Teacher)
- Introduction (2-4 paragraphs that demonstrate your understanding of the effects of greenhouse gases on warming of the planet).
- Body (2-3 pages that respond to the research question). Include an analysis of scientific data that you found from a reputable source.
- Paragraph that discusses the future implications related to your research question.
- Conclusion that connects your specific topic to greenhouses gases and global warming.
- Works Cited Page using MLA format.
- Evaluation of your sources in paragraph form at the bottom of the Works Cited Page. This should be a paragraph where you complete a critical analysis of the “worthiness” of your sources. This should include not just the “what”, but the “why”.
- Include the data/graph you analyzed in an appendix. Be sure to include a caption that explains the trend your research question addressed.

Your essay will be graded on criterion A: One World and Criterion B: Communication. You can find a detailed rubric attached. The following descriptors from the rubric might be helpful.

- *The student explains how science is applied to the consideration of a specific local or global issue.*
- *The student explains some of the benefits and limitations of science in addressing the issue.*
- *The student discusses how science and its applications interact with two or more of the following factors; social, economic, political, environmental, cultural and ethical.*
- *The student communicates scientific information effectively using sufficient scientific language correctly.*
- *The student presents all the information appropriately using symbolic and/or visual representation accurately according to the assignment, producing a very clear meaning.*
- *The student fully acknowledges sources of information appropriately and accurately.*

Timeline:

Teacher NOTE: Here is a timeline that worked well in our Honors Chemistry classes:

- Wed/Thurs 3/27-28 (computers available in class) intro to project; class time for PhET sim exploration; read background info complete PhET questions; define vocab.; determine focus (research question)
- Tues/Wed 4/9-10 research question and 3 sources due for paper
- Mon/Tues 4/15-16 (computers available in class) project work time – rough draft should be done
- Wed/Thur 4/17-18 project paper due

Handout#2: Grading Rubric – Greenhouse Gases/Climate Change Paper

Criterion A: *Applied Science/World*
(page 1 of 2)

Name: _____

Paper Title: _____

Criterion A Score: _____ / 6

5-6	3-4	1-2	0	Comments
The student explains how science is applied to the consideration of a specific local or global issue.	The student describes how science is applied to the consideration of a specific local or global issue.	The student states how science is applied to the consideration of a specific local or global issue.	The student does not address a specific local or global issue.	<i>Address Local/Global Issue</i> 1
The student explains some of the benefits and limitations of science in addressing the issue.	The student describes some of the benefits and/or limitations of science in addressing the issue.	The student states some of the benefits or limitations of science in addressing the issue.	The student does not address any benefits or limitations of science in addressing the issue.	<i>Benefits and Limitations</i> 2
The student discusses how science and its applications interact with two or more of the following factors: social, economic, political, environmental, cultural and ethical.	The student discusses how science and its applications interact with at least one of the following factors: social, economic, political, environmental, cultural and ethical.	The student briefly describes how science and its applications interact with at least one of the following factors: social, economic, political, environmental, cultural and ethical.	The student does not address how science and its applications interact with any of the following factors: social, economic, political, environmental, cultural, and ethical.	<i>Application and Interaction of Science and Society</i> 3

Criterion B: *Scientific Communication* Name: _____

(page 2 of 2)

Paper Title: _____

Criterion B Score: _____ / 6

5-6	3-4	1-2	0	Comments
The student communicates scientific information effectively using scientific language correctly .	The student communicates scientific information using scientific language, sometimes struggling with meaning and connections.	The student attempts to communicate scientific information using some scientific language, sometimes struggling with meaning and connections.	The student does not attempt to communicate scientific information using scientific language.	<i>Using Scientific Language</i> 1
The student presents all the information appropriately using symbolic and/or visual representation accurately according to the assignment, producing a very clear meaning .	The student presents most of the information appropriately using symbolic and/or visual representation according to the assignment, sometimes inaccurately, but still producing a clear meaning .	The student presents some of the information in an appropriate form using some symbolic or visual representation when appropriate. Much of it is presented inaccurately producing an unclear meaning .	The student does not present information in the appropriate form using symbolic or visual representation.	<i>Symbolic and Visual Representation</i> 2
The student acknowledges sources of information appropriately and accurately .	The student acknowledges sources of information with occasional errors .	The student attempts to acknowledge sources of information but often is done inaccurately .	The student does not acknowledge any sources.	<i>Source Acknowledgement</i> 3

HANDOUT #3

Greenhouse Gases PhET

Name _____ Period _____

(<http://phet.colorado.edu/en/simulation/greenhouse>)

DIRECTIONS: After you have had the opportunity to investigate the Greenhouse Gases PhET site, go to the specific tab and record the following information.

Green House Effect Tab:

1. What do the yellow and red circles represent?
2. Describe in one to two sentences your general observations that describe the photons represented in the PhET.
Write your response on the back of this page.

3. Ice Age

Click on the “Ice Age” button and let it run for a minute or so. Record the minimum temperature. _____
Record the amount of: CO₂ _____ CH₄ _____ N₂O _____

1750

Reset. Click on the “1750” button and let it run for a minute or so. Record the minimum temp. _____
Record the amount of : CO₂ _____ CH₄ _____ N₂O _____

Today

Reset. Click on the “Today” button and let it run for a minute or so. Record the minimum temp. _____
Record the amount of: CO₂ _____ CH₄ _____ N₂O _____

4. Briefly describe how the Greenhouse Gases affected Earth’s atmosphere during the Ice Age, the year 1750 and Today. *Write your response on the back of this page.*

Glass Layers Tab:

5. Set the photon speed to the center. Record the temperature without glass plates. _____ K _____ °C
6. Record the temperature with the addition of one glass plate. _____ K _____ °C
7. Record the temperature with the addition of two glass plates. _____ K _____ °C
8. Record the temperature with the addition of three glass plates. _____ K _____ °C

Summarize your observations on the back of this page. The glass plates are similar to the glass on a greenhouse. What do the glass plates represent in terms of the model?

Photon Absorption Tab: Complete the Table:

Atmospheric Gas	Behavior with IR Photon	Behavior with Visible Photon	Greenhouse Gas? (yes/no)

This computer simulation presents a *model* of global warming for a simplified Earth. Why are models important? What are some simplifications made by the computer programmers? Could a computer simulation of the of the Earth ever be 100% accurate? *Write a response on the back of this page.*