

Greenhouse Effect Argumentation (CER) Prompt

8.MS-ESS.3-5

Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century.

Suggested Progression:

- Greenhouse Effect Lab (see resource below)
- Background lesson on climate change & greenhouse effect
 - Demonstrating how burning fossil fuels leads to CO₂, which causes global temperatures to rise
- Greenhouse Effect Prompt
 - Graphic Organizer
 - Feedback (from peers or teacher)
 - Write prompt in paragraph form
 - Assess using rubric

Resources:

- ****AMAZING LAB ACTIVITY**** modified from link below
 - Adapted from <http://www.saferoutesinfo.org/sites/default/files/resources/PlanetConnecticut-Lesson1.pdf>
 - See next Page
- EPA Greenhouse Effect Video <https://www.youtube.com/watch?v=VYMiSule0Bw>
- Keeling Curve--Live data on interactive graphs from Mauna Loa
 - <https://scripps.ucsd.edu/programs/keelingcurve/>
- Youtube Video of CO₂ levels through time
 - https://www.youtube.com/watch?feature=player_embedded&v=bbgUE04Y-Xg
- PBS Greenhouse Effect Video
 - <http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.greenhouse2/global-warming-the-physics-of-the-greenhouse-effect/>
- EPA “Carbon Through the Seasons” Activity
 - <http://www.epa.gov/climatechange/kids/documents/carbon-through-the-seasons.pdf>
- Youtube Video about the Keeling Curve <https://www.youtube.com/watch?v=4ZlIM2oncnY>
- Blue Hill Observatory Climate Data <http://www.bluehill.org/climate/climate.html>
- Good Student-Friendly Reading about why the Keeling Curve wiggles:
 - How We Know What We Know About Our Changing Climate by Lynne Cherry and Gary Braasch (pg. 38 & 39)
- Global Land & Ocean Temperature Anomalies
 - http://www.ncdc.noaa.gov/cag/time-series/global/globe/land_ocean/ytd/12/1880-2014

Notes for Teachers:

- Graphic Organizers:
 - Try to offer a menu of graphic organizers for prewriting (including a blank page if students have a different structure in mind).
 - When using a graphic organizer, be clear to students about the purpose for the structure.
 - e.g. The reason there is a “Reasoning” box below every “Evidence” box is because we need to explain how each piece of evidence supports the claim.
- Rubrics--there are two different rubrics provided here
 - Teacher Rubric for Assessment
 - Clear outline for teachers of how to assess this particular prompt
 - DO NOT give to students--it clearly lists the expected claim, evidence, and line of reasoning.
 - Student Rubric
 - Share with students
 - Outline of what good claims, evidence, and reasoning are in general

Name _____

Greenhouse Effect Lab

Adapted from <http://www.saferoutesinfo.org/sites/default/files/resources/PlanetConnecticut-Lesson1.pdf>

Materials Per Lab Setup

Two empty plastic 2-liter soda bottles
Two bitherm thermometers (meat thermometers with range of 0-220° F)
One 150-watt work light with clip
up to 6 alka-seltzer tablets (generic is fine)
Clock or watch
Four cups of dark, dry soil
Water
Two 4 oz paper (or plastic) cups

Pre Lab Set-Up

1. Cut off the tops of the empty two-liter bottles to make two open-mouthed bottles eight inches in height. Using a utility knife, punch a small hole (for the thermometer) in each bottle 5 inches up from the bottom.
2. Place 2 inches of dry, dark soil in the bottoms of each plastic bottle. Insert a bitherm thermometer through the holes in the bottles so that their ends are in the middle of the air space.
3. Position the light 4 to 5 inches from the top of the bottles and equal distance from both.
4. Fill each cup half-way with water. Place each cup on top of the soil in the bottle, but to the side.

Running the Experiment

1. Check to make sure that:
 - a. The lamp is positioned 4 to 5 inches from the top of the bottles and equal distance from both.
 - b. Each bottle has a bitherm thermometer inserted through a hole in its side so that the end of the thermometer is in the middle of the air space.
 - c. Each bottle has a cup half-full with water.
2. Break three alka-seltzer tablets in half, then place in the cup. Immediately turn on the light and begin taking data (data table on other side).
 - a. One 2-liter bottle should now be filled with carbon dioxide (CO_2). (CO_2 is more dense than air, so it will stay in the container.)
 - b. Observe and record the temperature in each bottle every minute for 5 minutes on the data log. (The CO_2 will dissipate through convection currents set up by the warming environment.)
3. Turn off the light and let the bottles cool for about 5 minutes.
 - a. While you wait, calculate the maximum temperature increase in each bottle.
4. Repeat the experiment with only two tablets. Try it a third time with only one tablet.



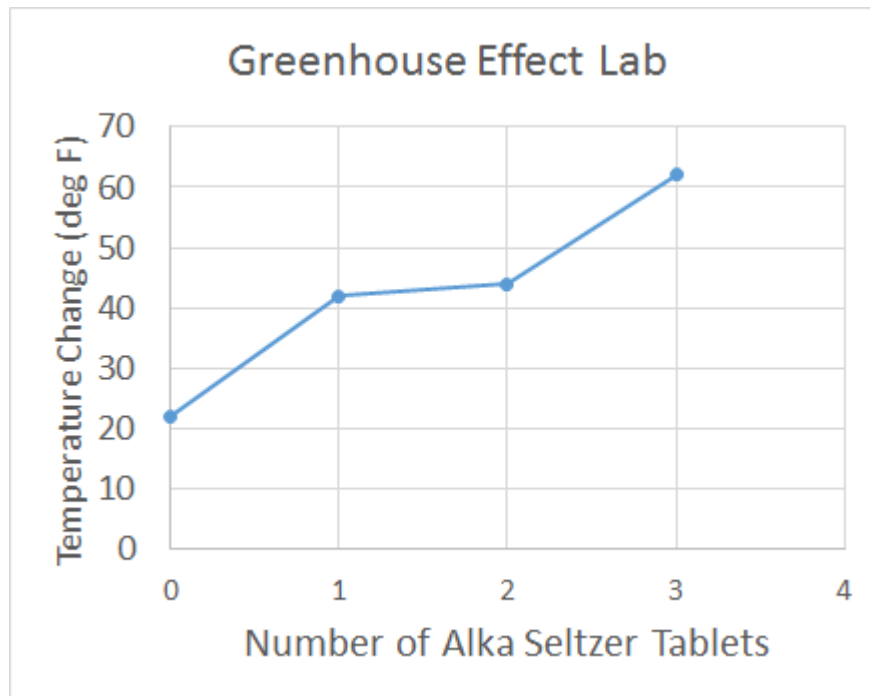
Greenhouse Effect Data Table

3 Alka-Seltzer Tablets				2 Alka-Seltzer Tablets				1 Alka-Seltzer Tablet		
Time (min)	T _{CO2} (° F)	T _{air} (° F)		Time (min)	T _{CO2} (° F)	T _{air} (° F)		Time (min)	T _{CO2} (° F)	T _{air} (° F)
0				0				0		
1				1				1		
2				2				2		
3				3				3		
4				4				4		
5				5				5		
MAX Temp Rise				MAX Temp Rise				MAX Temp Rise		

Greenhouse Effect Data Table

Sample Results (for Teacher Only)

3 Alka-Seltzer Tablets				2 Alka-Seltzer Tablets				1 Alka-Seltzer Tablet		
Time (min)	T _{CO2} (° F)	T _{air} (° F)		Time (min)	T _{CO2} (° F)	T _{air} (° F)		Time (min)	T _{CO2} (° F)	T _{air} (° F)
0	68	70		0	68	66		0	66	68
1	104	80		1	86	80		1	88	74
2	122	86		2	100	88		2	98	82
3	132	90		3	108	90		3	104	88
4	124	92		4	112	92		4	108	88
5	118	92		5	112	92		5	108	88
MAX Temp Rise	64	22		MAX Temp Rise	44	26		MAX Temp Rise	42	20



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Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century.

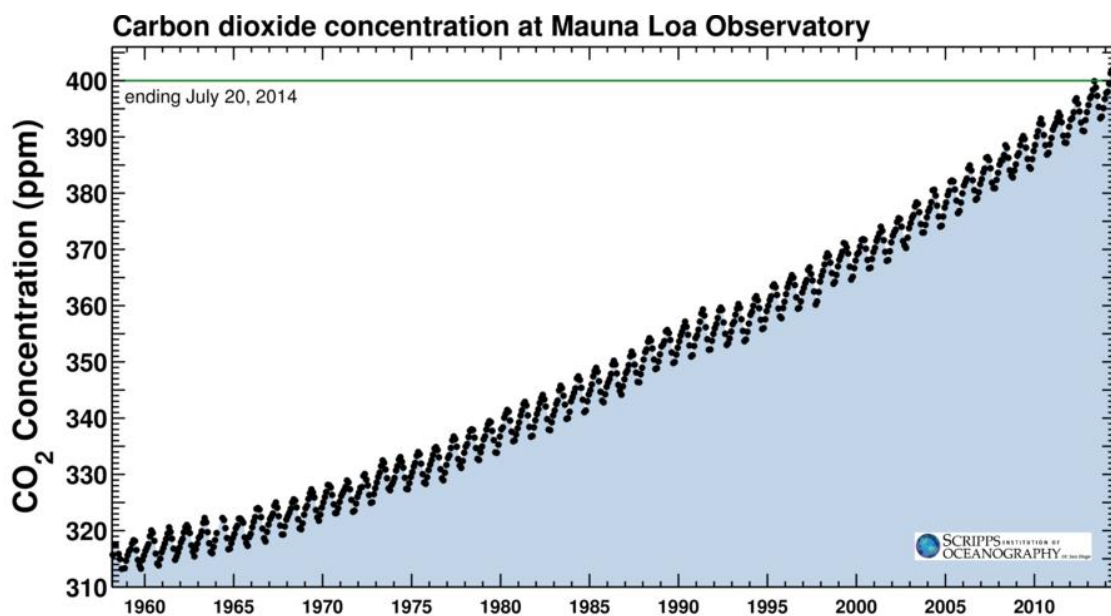
Scientists have collected data on the long-term climate, including measuring both average temperature and carbon dioxide (CO₂) levels.

Study the data in the three graphs below and on the next page, then answer this question:

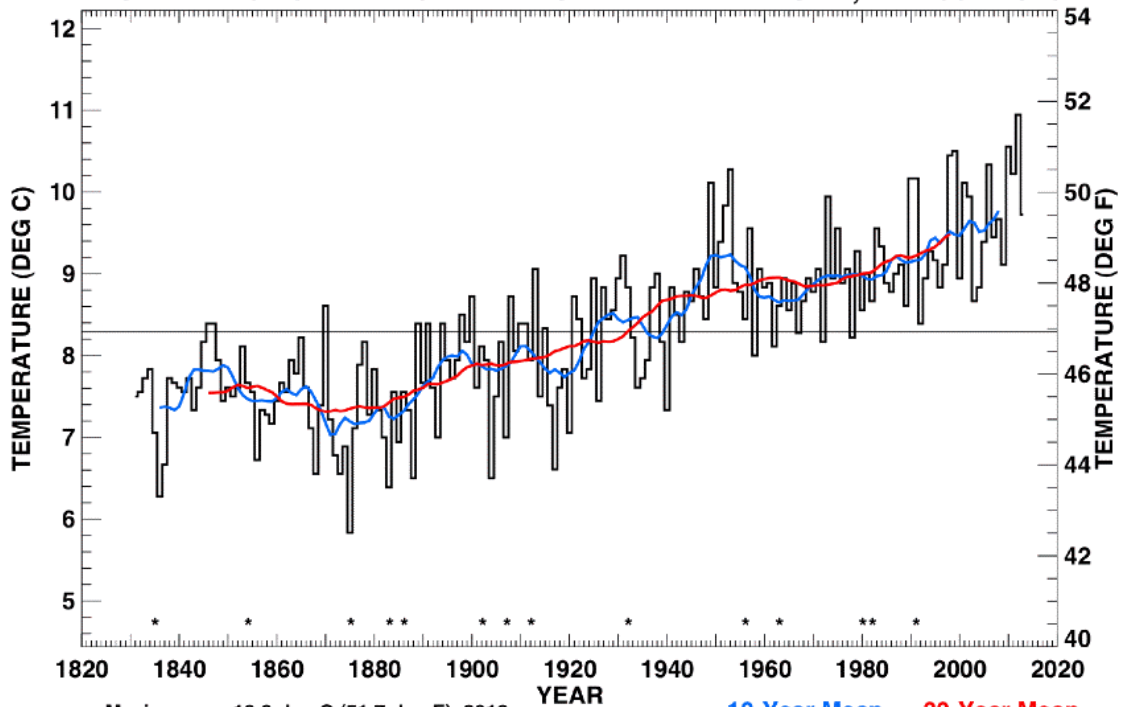
*What is the major trend in the temperature data,
and what is causing that to happen?*

Remember to include:

- *Claim: Answer the question.*
- *Evidence: Use data from your experiment and from the graphs to support your claim.*
- *Reasoning: Use information from readings or notes to explain why your evidence supports your claim.*



BLUE HILL OBSERVATORY ANNUAL TEMPERATURE, 1831-2013



Maximum: 10.9 deg C (51.7 deg F), 2012
 Minimum: 5.8 deg C (42.5 deg F), 1875
 Record Mean: 8.3 deg C (46.9 deg F)

10-Year Mean 30-Year Mean

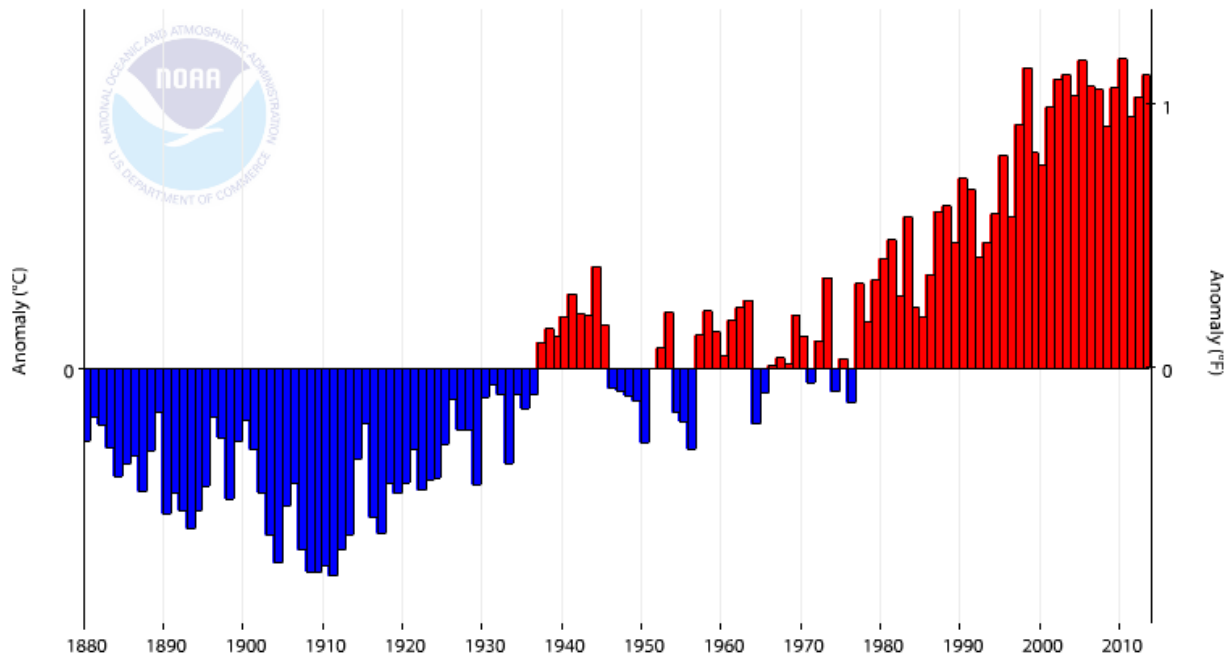
* Indicates dates of largest global volcanic eruptions.

Note: Plot includes temperature data for 1831-1884 from Milton and Canton that were adjusted to the Blue Hill summit location.

Michael J. Iacono, Atmospheric and Environmental Research / Blue Hill Observatory

<http://www.bluehill.org/climate/anntemp.gif>

Global Land and Ocean Temperature Anomalies, January-December



http://www.ncdc.noaa.gov/caq/time-series/global/globe/land_ocean/yttd/12/1880-2014

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Greenhouse Effect

Ideal Student Response

Answer the question:

What is the major trend in the temperature data, and what is causing that to happen?

Earth's temperature is rising several degrees Celsius as the result of increased carbon dioxide in the atmosphere. The Blue Hill Observatory data shows a rise of about 2°C from 1831 to 2013. The global land and ocean temperature has risen over 1°C since 1880. Both of these graphs show a clear trend of global warming. The Keeling curve shows the increase in carbon dioxide (CO_2) concentration in the atmosphere from 315 ppm in 1958 to about 400 ppm in 2014. Carbon dioxide is a greenhouse gas. In our experiment, we filled one bottle with air and another with CO_2 from an alka-seltzer tablet. When we placed both bottles under a heat lamp, the temperature of the bottle with more CO_2 rose by 42°F , compared to a temperature increase of 22°F in the bottle with just air. When we used two tablets of alka-seltzer, the temperature increase was 44°F , and three tablets led to an increase of 64°F . The increased level of CO_2 contributes to the greenhouse effect. The greenhouse effect is a natural process in which greenhouse gasses (CO_2 , methane, and water vapor) in our atmosphere trap heat on Earth like a blanket so that the planet is warm enough to support life. But additional carbon dioxide traps extra heat on Earth. In the experiment, more CO_2 added to the bottle clearly led to a higher temperature increase. The main sources of atmospheric CO_2 are from burning fossil fuels for electricity, transportation, and factories. When we burn fossil fuels like coal, petroleum, and natural gas, the chemical reaction produces CO_2 , releasing it into the atmosphere. With the increased use of fossil fuels, the CO_2 levels have risen, increasing the global temperatures.

Teacher Rubric for Assessment: Greenhouse Effect

	<i>4-Exemplary</i>	<i>3-Proficient</i>	<i>2-Needs Improvement</i>	<i>1-Critical Area</i>
<i>Claim</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Accurately states that temperature is rising as a result of increased atmospheric CO₂, using specific language that corresponds to the question. <input type="checkbox"/> Written in complete, easy to understand sentence(s). 	<ul style="list-style-type: none"> <input type="checkbox"/> Accurately states that temperature is rising as a result of increased atmospheric CO₂, using language that generally corresponds to the question. <input type="checkbox"/> Written in complete, easy to understand sentence(s). 	<ul style="list-style-type: none"> <input type="checkbox"/> Answers the question but uses vague or unclear language. <input type="checkbox"/> Inaccurately or incompletely answers the question. <input type="checkbox"/> Not written in complete, easy to understand sentence(s). 	<ul style="list-style-type: none"> <input type="checkbox"/> Does not make a claim, or makes a completely inaccurate claim.
<i>Evidence</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Provides specific, appropriate, and ample data or observations that supports claim, including: <ul style="list-style-type: none"> <input type="checkbox"/> Rising temperature data from global temperature graph. <input type="checkbox"/> Rising temperature data from Blue Hill Observatory graph. <input type="checkbox"/> Rising CO₂ data. <input type="checkbox"/> Temperature rise data from greenhouse effect experiment 	<ul style="list-style-type: none"> <input type="checkbox"/> Provides specific, appropriate, and sufficient data or observations that supports claim. May include some inappropriate evidence <input type="checkbox"/> Addresses 2-3 bullet points from Exemplary. 	<ul style="list-style-type: none"> <input type="checkbox"/> Provides appropriate, but insufficient or unclear data or observations to support claim. May include some inappropriate evidence <input type="checkbox"/> Addresses only 1 bullet point from Exemplary. 	<ul style="list-style-type: none"> <input type="checkbox"/> Does not provide data or observations, or only provides inappropriate evidence (evidence that does not support claim).
<i>Reasoning</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Correctly and clearly connects the evidence to the claim, showing how it supports CO₂ as the main cause of increasing global temperatures. <input type="checkbox"/> Discusses in depth the greenhouse effect. <input type="checkbox"/> Applies concepts that go beyond the prompt, as appropriate 	<ul style="list-style-type: none"> <input type="checkbox"/> Correctly and adequately connects the evidence to the claim, showing how it supports CO₂ as the main cause of increasing global temperatures. <input type="checkbox"/> Discusses the greenhouse effect. 	<ul style="list-style-type: none"> <input type="checkbox"/> Correctly connects the evidence to the claim, but leaves out important details, and/or <input type="checkbox"/> Restates the evidence without connecting it to the claim <input type="checkbox"/> Partially discusses the greenhouse effect. 	<ul style="list-style-type: none"> <input type="checkbox"/> Does not provide reasoning, or only provides reasoning that does not connect evidence to the claim, and/or <input type="checkbox"/> Provides an incomplete generalization or does not apply appropriate scientific concepts.
<i>Writing:</i> <i>Use appropriate structure, grammar, and mechanics to communicate your argument.</i>	<ul style="list-style-type: none"> <input type="checkbox"/> Writing contains no grammatical or spelling errors. <input type="checkbox"/> Writing is clear, concise, and persuasive. 	<ul style="list-style-type: none"> <input type="checkbox"/> Writing contains very few grammatical or spelling errors. <input type="checkbox"/> Writing is clear, mostly concise, and well developed. 	<ul style="list-style-type: none"> <input type="checkbox"/> Writing is fairly clear, with some grammatical or spelling errors. <input type="checkbox"/> Writing could be more concise. 	<ul style="list-style-type: none"> <input type="checkbox"/> Writing is difficult to follow, with many grammatical errors and no clear structure. <input type="checkbox"/> Writing is either too wordy or too incomplete.