

Carbon Cycle Lesson Plan for Middle School

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TITLE- “ A GLOBAL DILEMMA”

UNIT- GLOBAL CLIMATE CHANGE

GRADE LEVEL- 8th

TOTAL TIME INVOLVED:

3 class periods (average)

Some students took two days to complete the entire activity. Others took one to two days longer depending on academic ability.

OBJECTIVES:

Students will recall carbon sources and sinks

Students will read graphs and charts

Students will manipulate data on an applet

Students will make decisions using data

Students will synthesize information and create conclusions

Students will communicate results

Students will understand how carbon sources and sinks effect our climate

SUPPLIES and REFERENCES

Computer Lab

NATIONAL STANDARDS ADDRESSED

Standard F- Science in Personal and Social Perspectives

Natural Hazards

*Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans.

*Human activities also can induce hazards. Such activities can accelerate many natural changes.

*Natural hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

Risks and Benefits

*Students should understand the risks associated with natural hazards.

- *Individuals can use a systematic approach to thinking critically about risks and benefits.
- *Important personal and social decisions are made based on perceptions of benefits and risks

Science and Technology in Society

- *Science influences society through its knowledge and world view. Scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment.
- *Scientists and engineers work in many different settings, including colleges and universities, businesses and industries, specific research institutes, and government agencies.
- *Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

PRIOR KNOWLEDGE

Students should have some prior knowledge concerning the element carbon. They need to know that all living things have carbon in them. They should also understand that though Earth is warmed by the Sun, some heat radiation is returned to the atmosphere. Carbon dioxide and other gases in the atmosphere absorb this heat energy and radiate it in all directions. This energy radiated downward warms the surface of Earth and the lower atmosphere. Adding more carbon dioxide to the atmosphere means more heat radiation is captured by the atmosphere and is radiated back to Earth which raises the temperature of our planet.

Students also need some prior knowledge on fossil fuels, what they are, how they are formed, and how energy is released from those bonds.

PROCEDURAL OUTLINE

1. Students go to the following website: <http://carboncycle.aos.wisc.edu/>
2. Students complete the worksheet on the GCC website and applet. They will need a “working” understanding of this material to complete the simulation to follow.
3. Explain to your students that they will be involved with a simulation. Begin by reading them the MEMO to Planetary Earth Council Members.
4. Read the Simulation Instructions to students.

Overview:

- a. Planet Earth needs to install additional energy sources to supplement their current coal fired power plants because at the current time they are not providing enough energy for Earth’s consumers.

- b. According to the Universal Galactic Governing Alliance, the final decision concerning the new, supplemental energy source that must be added cannot significantly increase the amount of carbon dioxide in the atmosphere.
 - c. The Planetary Earth Governing Council has done the preliminary research and has narrowed down the additional energy source options to the following choices:
 - x. adding an additional coal fired power plant.
 - xx. adding a wood burning power plant
 - xxx. adding a wind turbine farm
 - d. Your mission, should you choose to accept it is to analyze the amount of carbon dioxide emissions that would be given off from each energy option being considered.
5. Give students the Dilemmas. They will then analyze the amount of carbon dioxide emissions that would be given off from each new energy option being considered.
6. Your team must utilize the graphs and the materials found in the software package to analyze these options. The software package is found at <http://carboncycle.asos.wisc.edu/>
7. You must present your findings and your final recommendations to the Universal Galactic Governing Alliance. These finding must include the impact on climate for each of the above options. Feel free to use graphs, charts, or other props for your presentation.

MEMO: To Planetary Earth Council Members

FROM: Universal Galactic Governing Alliance

Greetings Planetary Earth Council Members. It is with great anguish and frustration that we must send this interstellar memo to you. We recently received word that Planet Earth's current energy usage for its electronic devices, appliances, and contraptions has, once again exceeded the energy production efforts of your coal fired power plants. Drat!

Earth's citizenry has also been transmitting complaints to our Alliance regarding some "energy brownouts" in various locations around your planet. The Alliance understands your citizens' dependence on and acclimation to these electronic luxuries, however, we are not sure they truly comprehend your planet's current state of disorder. We question whether your citizens are making the connection between their personal energy consumption patterns and the instability that is occurring in Earth's atmosphere because of these actions. We believe your current "State of the Planet" has arisen from your citizen's prolonged resistance to change concerning their energy usage patterns.

Please note your planet's chronic state of instability. An inadequate energy plan, at this point in time, could lead to future mayhem, planetary disorder, or the complete dissolution of your solar body.

The Universal Galactic Governing Alliance has decided to allow you ONE more chance to get your energy needs in order. A member from our Alliance will be stopping by soon to scrutinize and inspect the plans for your additional energy source. If we feel that your Council is incapable of making an intelligent decision, we will be forced to take over governance of your planet.

Genuinely Concerned,
The Universal Galactic Governing Alliance



Universal Galactic
Governing Alliance

Global Climate Change Applet-Worksheet

Go to the following website: <http://carboncycle.aos.wisc.edu/>

1. Look at the **TABS** across the top of the page. You will be using your prior knowledge and the TABS to find answers to the following questions in the chart below.
2. To begin, click on the **APPLET** tab.
3. View BOTH the picture at the bottom of the screen and the 3 boxes in the MIDDLE of the page (sources, sinks, and controls). Click on the words in the boxes. You will see a change to the picture below. The images might provide you with clues to answer the questions.

QUESTION	ANSWER (USE APPLET AND TABS TO FIND ANSWERS)
<p>Look at the box in the middle of the applet. What are the words you find in the box under “Sources?” These “sources” contribute carbon to our atmosphere.</p>	
<p>Fossil Fuels are mentioned above as a “Source” of carbon.</p> <ol style="list-style-type: none"> a. What are fossil fuels? b. How do fossil fuels form? c. How does the carbon found in those fossil fuels end up in the atmosphere? 	<p>a.</p> <p>B</p> <p>c.</p>
<p>LAND USE is an additional “source” of carbon. The applet shows a forest burning. What does a burning forest have to do with an increase (or source) of carbon in our atmosphere? HINT: click on “land use” tab at the top of the page to read more</p>	

A Carbon “SINK” is the way that Earth can absorb and hold some of the carbon from the atmosphere.	
If “Ocean Uptake” is a SINK for carbon, where do you think some of the carbon is being absorbed to or held?	
What does “Land Uptake” mean? (HINT: use the TABS above to help).Where in the biosphere is some of the carbon absorbed and held?	

- Under the “SINKS” box you will find the “Control” box. Click on the Celsius button. Look at the graph on the right side of the page. You will see the axis (on the right hand side)change from Fahrenheit to Celsius. Now change it back to Fahrenheit.
- Look at BOTH graphs. Fill in the table below.

	Graph on LEFT side of the page	Graph on the RIGHT side of the page
What is the title of the graph?		
What information is found on the X axis?		
What information is found on the Y axis?	<p>PgC/year = 10¹⁵ grams of carbon</p> <p><i>The number on this axis is the amount of CARBON located in the atmosphere. PgC stands for Petagram. One PgC is equal to 1 gigaton or 1 billion tons.</i></p>	<p>Left side</p> <p>Right side</p>

6. Click on SOURCES: **FOSSIL FUELS** (middle box).
 MOVE the cursor over the left graph. (Don't click on it).
 You will notice that the TOP line of the graph is highlighted. This shows you that you have activated the **FOSSIL FUELS** portion of that graph.
 Click on **LAND USE**. Again, move the cursor over the left graph. You will notice the second line on the graph has gotten darker to show you have activated that line.
 Now click on **OCEAN UPTAKE** and repeat this process. Finally click on **LAND UPTAKE**. Each time you clicked on a different source or sink you activated that section of the graph.

7. Go back and click on **FOSSIL FUELS** again.
 As you move the cursor directly over that activated line you will notice that a box will appear above the line showing both the year and the amount of carbon added to the atmosphere from this source.

8. How is the orange line section different from the green line section?

9. What does the word "Projected" mean? _____

10. Using the **FOSSIL FUEL** graph, answer the following questions:
 - a. How much carbon from fossil fuels was placed in the environment in 1971? _____
 - b. In what year do we find approximately 15 PgC? _____yr_

11. Click on **LAND USE**. What is the amount of carbon added to the atmosphere from land use in 2010? ___PgC/yr
12. As you slide your cursor along this line, what happens to the amount of carbon due to land use from 2010 to 2080? Does it increase or decrease? _____

13. Click on **CARBON SINKS-OCEAN UPTAKE**. How much carbon are the oceans projected to absorb by 2080? _____ PgC/yr. This means it will take that amount OUT of the atmosphere and store it in the deep ocean. (*Ocean and Land lines run together. Be careful to identify OCEAN uptake. The pop-up box tells you this.*)

14. Notice the “ZERO” line. What does it mean if the data is above that line?
_____ What does it mean if the data is below that line? _____
15. Below the zero line you will see the **SINKS**. Move your cursor over the two lines below the zero line.
Circle the correct answer. Which line represents the **OCEAN UPTAKE** line (top or bottom). Which line represents the **LAND UPTAKE** line? (top or bottom)
16. Click on **SINKS: OCEAN UPTAKE**. Use your cursor and move over the graph line. What is the projected carbon uptake by the land in 2020? _____
17. Click on SINKS: **LAND UPTAKE**: Use your cursor and move over the graph line. What is the ACTUAL land uptake in 1990? _____ What is the PROJECTED land uptake in the year 2100? _____

DILEMMA ONE

Planetary Earth Council Members have decided to put in more COAL FIRED POWER PLANTS. After consulting the engineers, the Council understands that this source of energy will emit 25PgC/yr into the atmosphere each year until 2100.

1. Use the graph on the left side of the page. CLICK RESET button
2. Make sure you click SOURCES: FOSSIL FUELS in the control panel.
3. Drag all the green projection dots up to the 25PgC/year line. This is the amount of carbon that will be added to the atmosphere if we add a COAL FIRED POWER PLANT.
4. Click on “Run Projection” in the control panel.

FINAL RESULTS FOR A COAL FIRED POWER PLANT:

Look at the corresponding graph on the RIGHT side of the page.

What is the initial Atmospheric CO₂ reading? _____ (on the graph-far right. You will have to scroll)

What is the ending Atmospheric CO₂ reading? _____

What is the total amount of CO₂ added to the atmosphere? _____PgC/yr

What is the initial temperature change reading? _____

What is the ending temperature change reading? _____

What is the difference between the two readings? _____

The difference between the initial temperature change reading and the ending temperature change reading is the amount that our planet will be warming up if we implement a COAL FIRED POWER PLANT.

If the Council would decide to invest another ONE million dollars into a high-tech scrubbers over the next 90 years to **remove** some of the CO₂ from the Coal Fired Power Plant **before** some of this pollution reaches the atmosphere the data would change.

1. Click RESET in the control box. Click on FOSSIL FUELS
2. Move the green dot (closest to the orange section) to 25PgC/yr.
3. Move the next dot to 20 PgC/yr. Move the following dot to the 15 PgC/yr mark and continue moving the dots in

this fashion until the last diamond is placed on the zero line.

4. RUN PROJECTION

FINAL RESULTS FOR A COAL FIRED POWER PLANT WITH SCRUBBERS ADDED OVER THE NEXT 90 YEARS:

What is the initial Atmospheric CO₂ reading? _____

What is the ending Atmospheric CO₂ reading? _____

What is the total amount of CO₂ added to the atmosphere? _____ PgC/yr

What is the initial temperature change reading? _____

What is the ending temperature change reading? _____

What is the difference between the initial and ending temperature change? _____ This is the amount of temperature change our planet will see if we use COAL FIRED POWER PLANTS with scrubbers.

DILEMMA TWO

Planet Earth has millions of acres of lush, green forests. If the Planetary Earth Council decided to put in the wood burning energy plant, engineers explained that the amount of CO₂ emitted into the atmosphere from this plant will be approximately 20PgC/yr.

1. Click RESET
2. Click on LAND USE.
2. Move each green dot to the to15 PgC/yr.
3. Run Projection

FINAL RESULTS FOR A WOOD BURNING ENERGY PLANT

What is the initial Atmospheric CO₂ reading? _____

What is the ending Atmospheric CO₂ reading? _____

What is the total amount of CO₂ added to the atmosphere? _____ PgC/yr

What is the initial temperature change reading? _____

What is the ending temperature change reading? _____

This means that the total temperature change for our planet will be _____ if we implement a WOOD BURNING POWER PLANT.

DILEMMA THREE

Planet Earth has wide open spaces that are perfect for wind farms. The wind turbines would cost significantly more money initially than either of the other energy options. It would take at least 50 years to make a profit. But the engineers also noted that the Council would never need to build another coal fired power plant because these new wind turbines would supply all

the additional energy that is needed. Engineers explained that the amount of CO₂ emitted into the atmosphere from this plant will be approximately 0 PgC/yr, such that total emissions would hold steady at 8.4 PgC/yr for the next 100 years. The wind turbine does need electricity to run all of the following: its nacelle (turbine housing), yaw mechanism (to keep the blades perpendicular to the wind, blade/pitch control to keep the rotors spinning at a regular rate, lights, data collection, pumps, coolers, gear boxes and brakes. Because of this fact, you will be clicking on FOSSIL FUELS for this dilemma.

1. Click the RESET button.
2. Click on FOSSIL FUELS
3. Drag all the dots to the 8.4 PgC/yr
4. Run Projection.

5. FINAL RESULTS FOR WIND FARM AS A SOURCE OF ENERGY

6. *What is the initial Atmospheric CO₂ reading? _____*
7. *What is the ending Atmospheric CO₂ reading? _____*
8. *What is the total amount of CO₂ added to the atmosphere? _____PgC/yr*
9. *What is the initial temperature change reading? _____*
What is the ending temperature change reading? _____

What is the difference between the initial and ending temperature change readings? _____ This amount is how much our planet will warm up in the next 100 years.