4.2 - Ecosystems Unit, Packet 2

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How does human activity affect species?

Anchoring Phenomenon:We previously explored how resilient ecosystems recover from disturbances. Now, we'll delve into how human activities disrupt ecosystems, impacting their function and biodiversity. In particular, we will focus on how and why we're currently experiencing rapid changes to climate.

Deeper Questions

1. How do imbalances in matter and energy occur?
2. What happens when matter and energy are unbalanced?
3. How does human activity relate to these kinds of disturbances?

Schedule

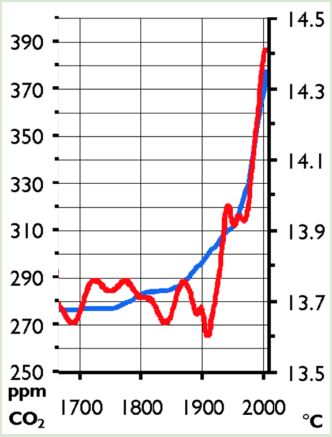
Part 1: Introduction
- Initial Ideas & Data Dive - GHG Graphs
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

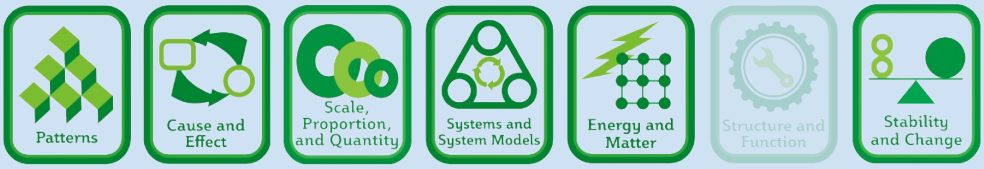
Part 3: Investigation
- GHG Simulation

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Mendota Ice



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
S-ESS2-2 Earth's Systems. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-4 Earth's Systems. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS2-6 Earth's Systems. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS3-6 Earth and Human Activity. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do cells acquire atoms from food?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

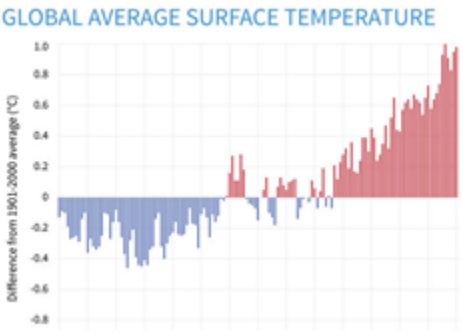
4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Part 1 Video; Part 3 GHG Simulation; Part 3 Detailed Instructions; Part 5 Mendota Ice Data; NASA CO_2 Data Video;

Part 1: Introduction – GHG Graphs (4.2.1)

Overview: In this activity, you will begin by discussing your initial ideas about how imbalances in matter and energy affect ecosystem function. You will then analyze data and develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence



1. Over the past decades, the average surface temperatures on the planet have increased fairly consistently (see graph →). Three students shared their ideas about why this warming is occurring. **Do you agree or disagree with each student's claim?**

- Mike: "The earth is simply going through a natural cycle like it always has." *Agree/ Disagree*
- Lucia: "I think that human activity is primarily responsible for this warming." *Agree / Disagree*
- Oscar: "I think that these changes are due to a variety of factors like sunspots, volcanic activity, natural cycles, and maybe human activity too." *Agree / Disagree*

2. Work in your small groups to discuss your ideas. How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

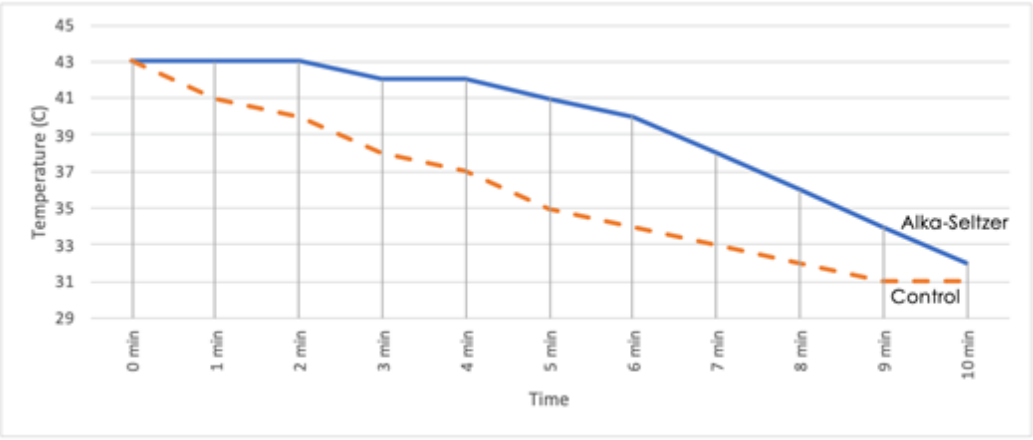
Data Dive 1 - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

Next, watch this video individually or as a class (based on your teacher's instructions):

Then look at the data below. Students raised carbon dioxide levels inside a sealed beaker using water and Alka-Seltzer tablets. They compared this to another beaker with the same water amount but no treatment (control). Both were heated to 43°C (110°F) and then left to cool. The temperature in each beaker was recorded every minute. See their recorded data below.

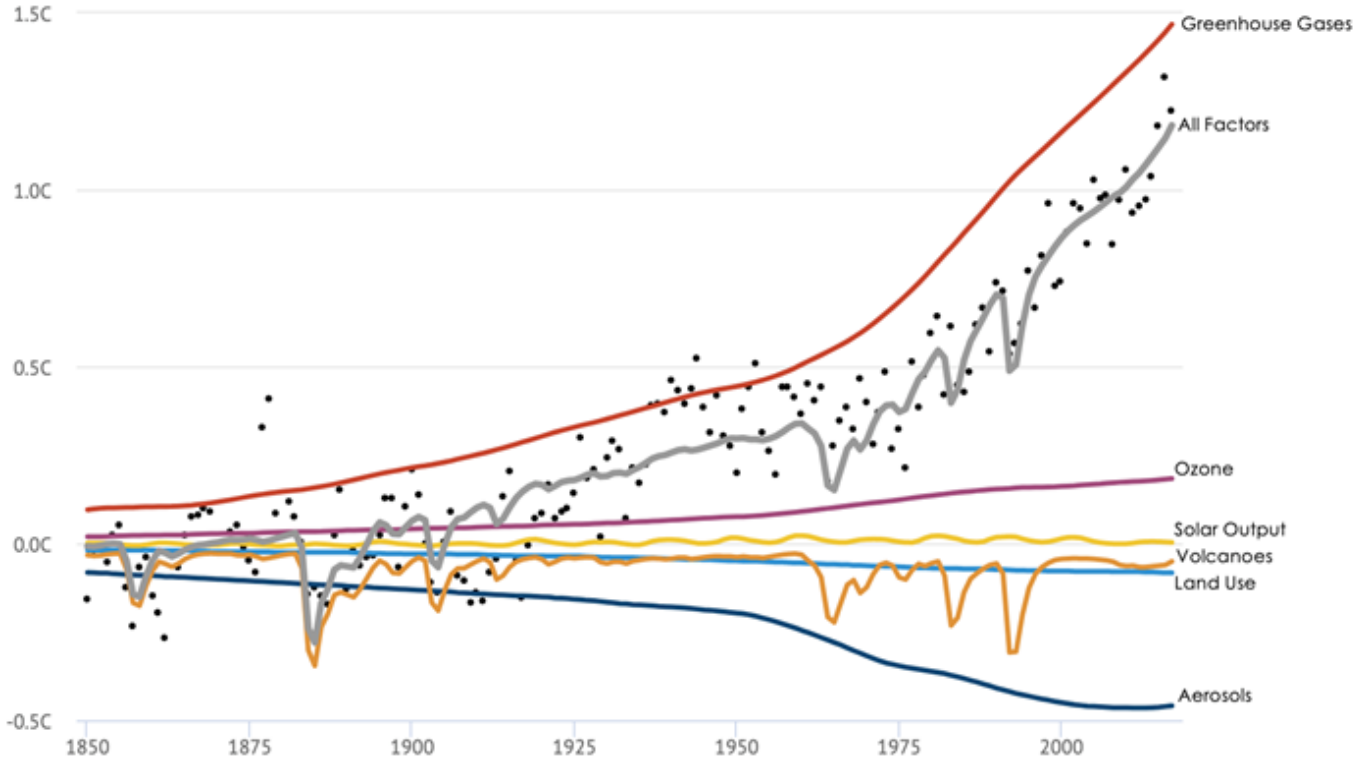
What are two conclusions that would be supported by this data? What specifically suggests that your claim is accurate? Use the data below to support your claims.

Time	Alka-Seltzer	Control
0 min	43	43
1 min	43	41
2 min	43	40
3 min	42	38
4 min	42	37
5 min	41	35
6 min	40	34
7 min	38	33
8 min	36	32
9 min	34	31
10 min	32	31



Data Dive 2 - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

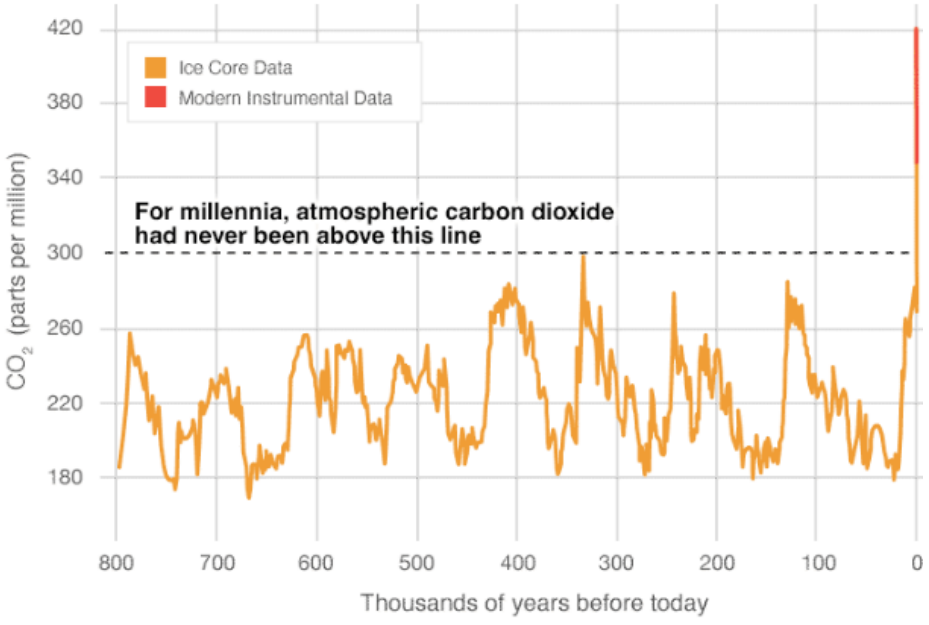
The earth's average surface temperature is shown in the graph below as a series of dots. Scientists compared the impact of six different factors that affect temperature, including: 1) land use (such as deforestation), 2) ozone levels, 3) greenhouse gases, 4) solar energy output, 5) aerosols, and 6) volcanic activity. **What are two conclusions that would be supported by this data?** What specifically suggests that your claim is accurate? Use the data below to support your claims. *(Sinclair, 2014)*



Data Dive 3 - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

This NASA graph shows changes in CO_2 levels over the previous 800,000 years. This data was recorded using ice core data.

1. What was the maximum CO_2 level before the 1900s?
2. What is the current level of atmospheric CO_2?
3. Why do you think CO_2 is so much higher now? Why is CO_2 being released at a faster rate than it is being absorbed?



Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

How and why do greenhouse gases (GHGs) affect temperature? How do rising GHG levels disrupt ecosystems? Write down an initial explanation below. Don't worry if you aren't completely sure about this. You will revise this explanation as you gain more information during this unit.

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 2: Core Ideas (4.2.2)

Overview: In this activity, you will use a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. How did an asteroid strike 65 million years ago disrupt all ecosystems and cause the extinction of the dinosaurs? Address factors at the molecular, cellular, organismal, and ecosystem levels.
2. What is necessary for ecosystems to function in regards to changes to matter and energy?
3. How do current rates of CO_2 emissions compare to rates of CO_2 absorption? Why is this occurring?
4. Why does the moon have more widely fluctuating temperatures compared to the earth if both are roughly the same distance from the sun?
5. True or false: CO_2 is only a small percentage of the earth's atmosphere; therefore, changes to CO_2 concentrations are unlikely to have a major impact on temperature. Explain.
6. What is a greenhouse gas? What determines if a molecule can act as a greenhouse gas?
7. What is the greenhouse effect?
8. What is infrared radiation? How do light and infrared radiation relate to the greenhouse effect?
9. Could recent changes in global temperatures be part of a natural cycle? Use the term *Milankovitch Cycles* in your response.
10. What is climate change? How does it relate to changes in CO_2 concentrations?
11. How do changing CO_2 levels affect ecological factors such as vegetation, oxygen, precipitation patterns, and ocean acidification?
12. True or false: while rising CO_2 levels are affecting ecosystems, human activity is largely unaffected by climate change. Explain.

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

How and why do greenhouse gases (GHGs) affect temperature? How do rising GHG levels disrupt ecosystems? Based on this new information, how would you now respond to this question?

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 3: GHG Simulation (4.2.3) *Adapted from materials by Carbon TIME*

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. How can imbalances in matter and energy result in an ecosystem disruption?
2. What is a greenhouse gas? What is the greenhouse effect? What makes a molecule a greenhouse gas?
3. How do we know that changes to the earth's climate aren't just part of a natural cycle?
4. How do changes in greenhouse gas levels disrupt ecosystems? Provide specific examples.

This activity was completed _____ (*instructor signature*)

Overview: This activity requires you to use a computer simulation to explore what makes a molecule a greenhouse gas, and how changing the concentration of a greenhouse gas affects temperature.

Trial 1 - How different gases interact with photons. *SEP: Planning and Conducting an Investigation*

1. ☐ First, predict how greenhouse gas (GHG) molecules like CO_2 will interact differently with light and infrared radiation compared to non-GHG molecules like N_2 and O_2.

   I predict the following: _____

   _____

   _____

2. ☐ In an internet search engine, type *PhET Greenhouse Gas Simulation,* or click the URL below: https://phet.colorado.edu/sims/cheerpj/greenhouse/latest/greenhouse.html?simulation=greenhouse
   Use the worksheet on the following pages to record your responses.
3. ☐ Find detailed instructions by clicking here or by visiting your instructor's website / Google classroom.
4. ☐ Open the PhET simulation. Open the Photon Absorption Tab (in the upper left). You will be comparing how both CO_2 and N_2 interact with each kind of radiation (light and infrared).
5. ☐ On the "Atmospheric Gases" panel, select CO_2. On the "radiation gun" on the left hand side of the screen, make sure that the "Visible Photon" option is selected. Move the slider on the gun all the way to the right and observe how the infrared photons respond when they encounter the CO_2 molecule. Record your data in Results.
6. ☐ Now change the "radiation gun" so that the "Infrared Photon" option is selected. Move the slider on the gun all the way to the right and observe how infrared photons interact with CO_2. Record your data in Results.
7. ☐ Under the "Atmospheric Gases" panel, select N_2. Repeat the previous steps using light and infrared photons. Record your data in Results.

Results - Trial 1. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

1. **Circle the most accurate descriptor below for the movement of each kind of photon in each case.**

When a visible light photon hits CO_2, the photon's movement is…	**Unchanged**	**Scattered**
When an infrared photon hits CO_2, the photon's movement is…	**Unchanged**	**Scattered**
When a visible light photon hits N_2, the photon's movement is…	**Unchanged**	**Scattered**
When an infrared photon hits N_2, the photon's movement is…	**Unchanged**	**Scattered**

2. **How were the interactions between CO_2 and infrared photons different from CO_2's interactions with light photons?**

_____

_____

3. **How and why did the infrared photons react differently with CO_2 compared to N_2?**
(Hint: how many atoms & elements are in each molecule? Which molecule meets the criteria to be a greenhouse gas?)

_____

_____

Trial 2 - How different gases affect the Earth's temperature. *SEP: Planning and Conducting an Investigation*

8. ☐ The earth's atmosphere is comprised of a variety of gases. Predict how changing the concentration of greenhouse gases will change how light and infrared radiation move in and out of the atmosphere:

   I predict the following: _____

   _____

   _____

9. ☐ Open the Greenhouse Effect Tab (in the upper left).
10. ☐ In the "Greenhouse Gas Concentration" panel on the right, move the slider to "None".
11. ☐ Watch the yellow light photons as they move from outer space to the surface of the earth. Then watch the red infrared photons as they move from the surface of the earth to outer space. In Results, record whether the movement of these photons changes (*scattered*) or is unchanged.
12. ☐ Look at the thermometer on the left-hand side of the screen. Record the temperature that occurs under these conditions. Record your data in Results.
13. ☐ In the "Greenhouse Gas Concentration" panel, move the slider to "Lots". Observe the movement of both the yellow light photons and the red infrared photons. In Results, record whether the movement of these photons changes (*scattered*) or is unchanged. Also record the temp under these conditions.

Results - Trial 2. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

	Impact on Yellow Light Photons	Impact on Red Infrared Photons	Temperature Range
Low GHG's			
High GHG's			

1. **How did the movement of yellow light photons differ from the movement of red infrared photons in this simulation?**

_____

_____

2. **How do your observations in this simulation relate to the Greenhouse Effect?**

_____

_____

3. **What happened to the temperature as the concentrations of greenhouse gases were increased? How is this similar to what is currently happening in the earth's atmosphere?**

_____

_____

4. **If concentrations of greenhouse gases continue to increase, how would this affect a) ecosystems, b) biodiversity, and c) human activity? Support your claims with evidence & reasoning.**

_____

_____

_____

Part 4: Review & Assessment (4.2.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check. If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections – Mendota Ice (4.2.5)

Reading - *Complete the reading below. Use the space on the right to annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading.*
SEP: Obtaining, Evaluating, and Communicating Information

Background: The University of Wisconsin - Madison is located along the shore of Lake Mendota. Since the 1850s, researchers have recorded when Lake Mendota freezes and thaws. They use this data to calculate the *ice duration* for each year. This is the total number of days the lake is completely covered in ice.

Ice duration data provides a long-term climate record for the region. While daily temperatures can fluctuate, lake ice provides a reliable record of average yearly temperatures. This data helps us understand how our climate has changed and will continue to change over time. Because this data was collected when the Industrial Revolution began, it also helps us to understand how human activity affects climate.

Ecologist John Magnuson utilized this data to investigate how Lake Mendota's freeze and thaw dates have changed. He hypothesized that gases like CO_2 were causing a decline in total ice cover. He thought this because CO_2 is a greenhouse gas and its concentrations have increased each year. Dr. Magnuson analyzed this data to calculate the change in the average number of days the lake was frozen each decade. His findings reveal a 25% reduction in ice duration since the 1800s. This decline is accelerating with each passing decade. If this pattern persists, it is likely that lakes like Mendota will cease to freeze in the future.
(Magnuson, 2021; Imrit & Sharma, 2021; Gloege, 2021; Hamilton, 2019; Duncan, 2015)

Driving Questions:
1. **How can ice data from Lake Mendota tell us how the climate is changing?**

2. **What was Dr. Magnuson's:** *(underline and label each)*
- Research question (RQ)
- Hypothesis (HY)
- Rationale (RA)
- Independent Variable (IV)
- Dependent Variable (DV)

3. **How did Dr. Magnuson test this hypothesis?**

Questions - *Answer the following questions based on the reading on the previous page..*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

1. **Briefly summarize Dr. Magnuson's research question (RQ), hypothesis, and rationale:**

   RQ: _____

   Hypothesis: _____

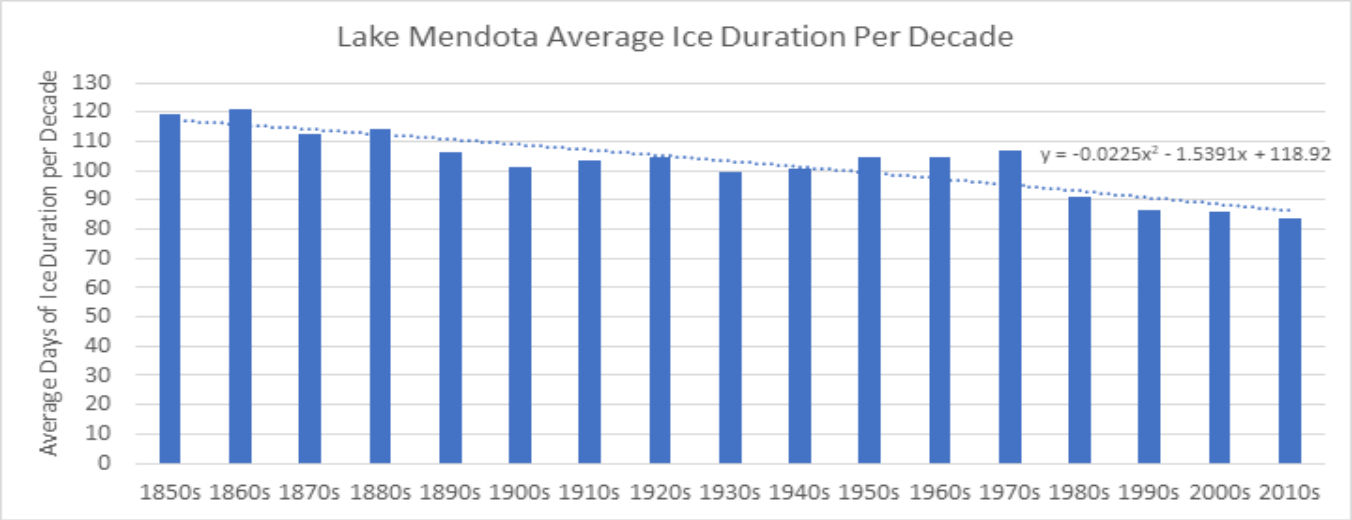
   Rationale: _____

2. **What were Dr. Magnuson's independent and dependent variables in this experiment?**

   Ind. Var.: _____

   Dep. Var.: _____

Dr. Magnuson's data is shown below. Each decade is shown on the x-axis. The average ice duration (average days of total ice cover) for each decade is shown on the y-axis. There is also a dotted trendline on this graph. A trendline shows patterns on a graph based on the average values of the data. *(Data Source)*



3. **Is Dr. Magnuson's hypothesis supported by this data? How do you know? Refer to specific parts of these graphs to support your claims (it is ok to draw arrows from your text to the graphs).**

   _____

   _____

4. **Based on this data, make a prediction about how the ecosystems of Wisconsin will change in the coming decades, and how this might affect both species interactions and human activity.**

   _____

   _____

   _____

Ecosystems Packet 2 Formative Assessment (4.2.4)

Name: _____Hour____Date:_____Score:_____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

1. **Briefly summarize how and why imbalances in matter movement and the flow of energy from an asteroid strike caused the dinosaurs to go extinct.** Explain how and why these changes occurred at the ecosystem, organismal, cellular, and molecular-atomic levels.

_____

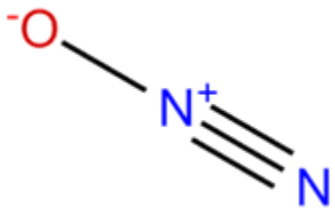
_____

_____

_____

Writer's Name:

2. This is Nitrous Oxide (N_2O). It consists of two elements (oxygen and nitrogen) and has three atoms. **A) If atmospheric levels of N_2O increase on Planet X by 50%, how would this affect the movement of light and infrared radiation? B) How would this change conditions on the surface of the planet?** Explain & justify w/ evidence. Include the following: *greenhouse gas; infrared radiation.*



_____

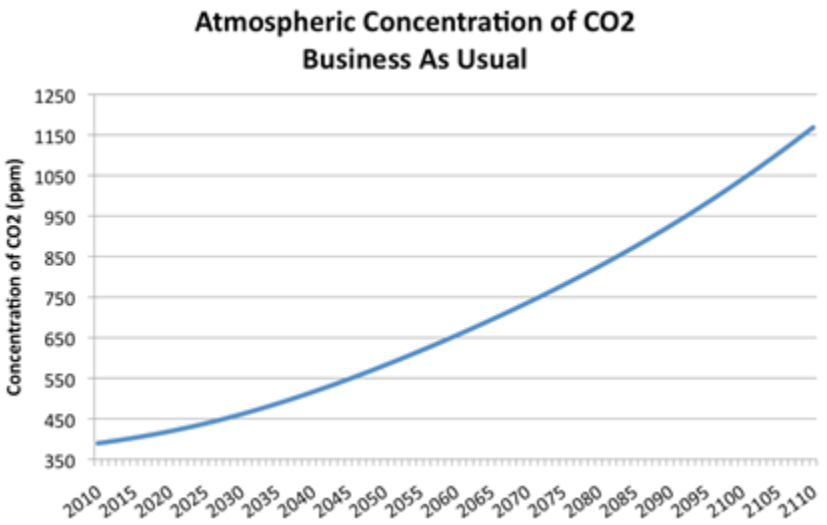
_____

_____

_____

Writer's Name:

3. The graph shows how CO_2 levels will change under a "business as usual" scenario (i.e., no changes to the current CO_2 emissions). **What are some outcomes that we would expect if CO_2 levels were to continue to increase at this rate?** In your response, explain a) the relationship between CO_2 and temperature, and b) how changing levels of CO_2 result in different kinds of ecosystem disturbances.



Writer's Name:

4. **Are the changes that are now happening in climate due to natural cycles? Are they due to other natural factors like volcanoes or sunspots?** Support your ideas using evidence and reasoning.

Writer's Name: