Nature of Science
&
The Greenhouse Effect

Session 6

Quick Write

Based on what you know now, what role(s) do you think that this crosscutting concept might play in understanding climate change?

Session Goals

- **Climate science Ideas:** Engage in an activity and use a model to explore the greenhouse effect.
- **Using Data:** Build on skills covered in previous sessions, especially those related to models.
- **Teaching and Learning:** Review how the Five Foundational Ideas and Learning Cycle instructional model can be used to design effective activities to achieve deeper conceptual understanding.
- **Framework/NGSS:** Examine how the Crosscutting Concept of Energy and Matter can support evidence-based connections about climate change. Engage in discussions and explore ideas about the nature and practices of science.

What is and is not science?

- Taking a critical look at what are and are not accurate views of science can help hone our own understanding of science.
- In teaching about science, it's vital to spend time thinking about the nature of science and how it can be communicated.
- If learners don't have a good understanding of what science is, they'll have a difficult time determining which questions science can and can't answer.
- Understanding what science is and what it is not helps us become critical consumers of information, better able to engage in decision-making as knowledgeable citizens.

Nature of science

- Characteristics of science and the knowledge that science produces.
- What a scientist would be doing to signify that s/he was “doing science”.

Think-Pair-Share

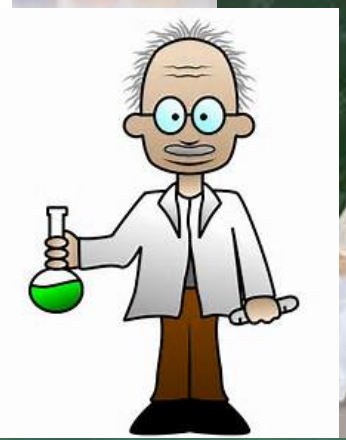
What is science?

What is it not?

What is a scientist?
Google search Aug 2016

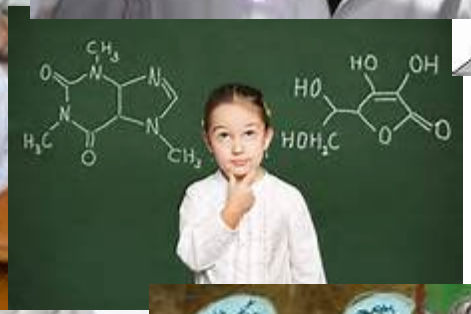


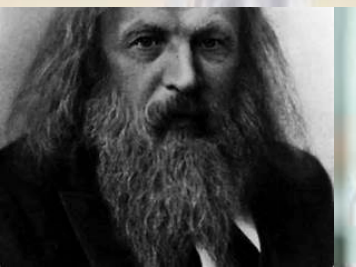






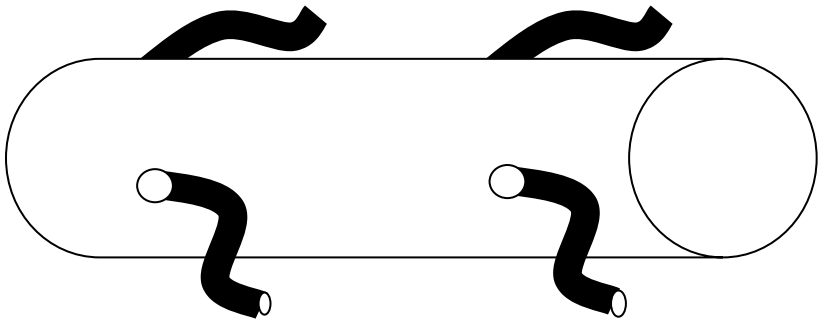


Mystery Tubes

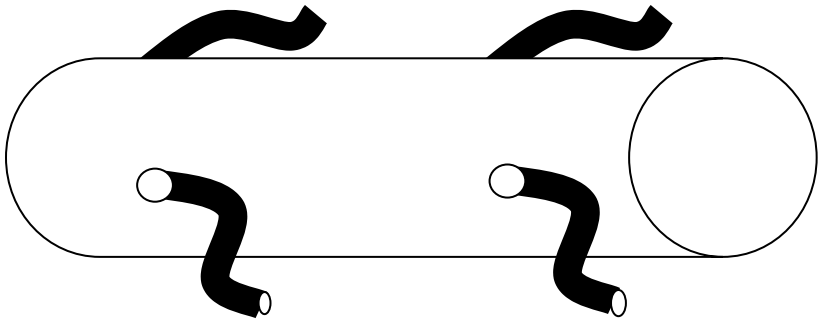
- Work in two's or three's to explore the mystery tubes & share ideas.
- Your goal is to determine what the interior construction of the tubes looks like & to draw a diagram to model your hypothesis.

You cannot open the tubes to look inside.



Mystery tubes

1. Share your model with another group.
2. What would you say if you were going to publish your findings right now?
3. Make sure to comment and ask questions about each other's models.

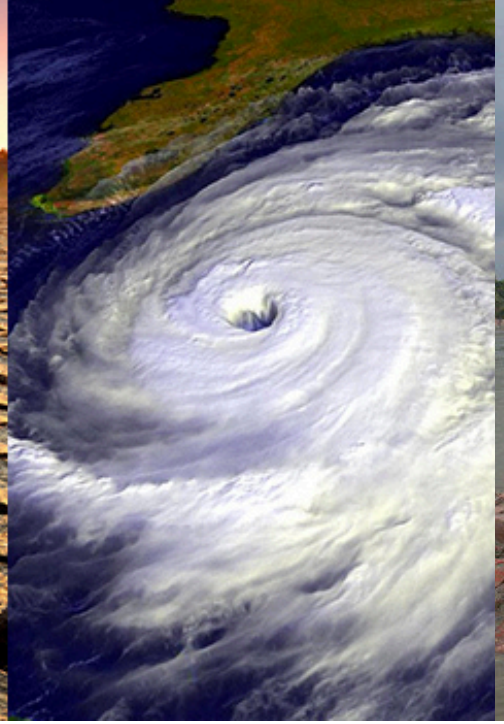


Activity Debrief

- Were you “doing science”?
- What were you doing that is similar to what scientists do?

California

Sub-Saharan Africa



Off the coast of Florida

Bangladesh

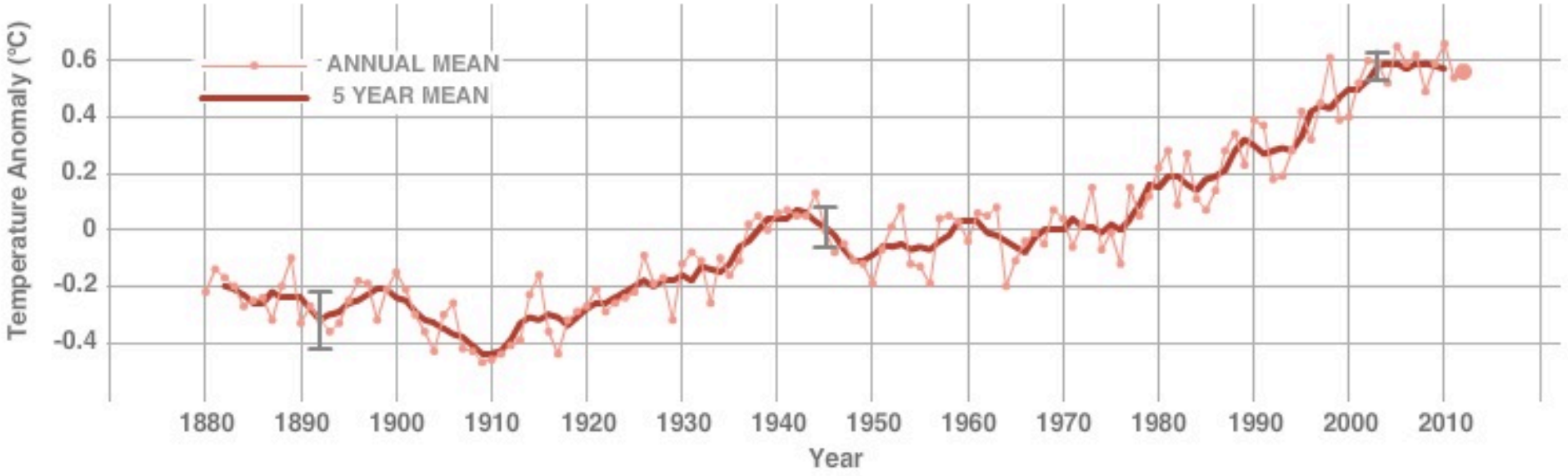
- What do you notice across the images?
- What do you think is causing the phenomena shown in the images to happen?
- What do you know about the cause(s) of climate change?

About climate change

- The average sea level has been rising steadily since the late 19th century; some places are experiencing even greater sea level rise than the average.
- The 10 warmest years in the last almost 150 years all have occurred since 2000, with the exception of 1998. The year 2016 ranks as the warmest on record. (Source: NASA/GISS).
- Climate change is a change in weather patterns over time – spanning years, decades, centuries, and even longer.
- Scientists agree that the climate is changing and it is human-caused due to the release of vast amounts of CO_2 from human activities.

GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS) This trend agrees with other global temperature records provided by the U.S. National Climatic Data Center, the Japanese Meteorological Agency and the Met Office Hadley Centre / Climatic Research Unit in the U.K. Credit: NASA/GISS



Sketch a diagram that depicts your current understanding of the greenhouse effect. Make sure to:

- Label your diagram
- Include CO2 in you diagrams however you think it makes sense.
- Record any questions you have about the greenhouse effect on the side of your diagram.

Predictions

- What do you think will happen to the temperature of the "atmosphere" after the soil in the bottle is heated by the "sun" (microwave)?
- What will happen when additional heat-trapping gas (CO_2 from Alka Seltzer) is added to the atmosphere in the experimental bottle? (Alka Seltzer is used in the model to represent increasing CO_2 entering the atmosphere).
- What do you think we will find out about climate change/ which of your questions about climate change do you think this demonstration will answer?

Small Group Discussions

- How might you explain the temperature change?
- What does this model demonstrate about the relationship between increasing CO_2 in the atmosphere and the temperature on Earth?
- Why does the temperature change with the influx of CO_2?
- What do you think this temperature change resulting from CO2 has to do with climate change?
- In what ways is this model an accurate representation of the phenomenon and what are its limitations?

Refining your explanation

- Add to/revise your greenhouse effect diagram to reflect your current thinking
- Record any questions you still have.

Small Group Share

With another small group, share your:

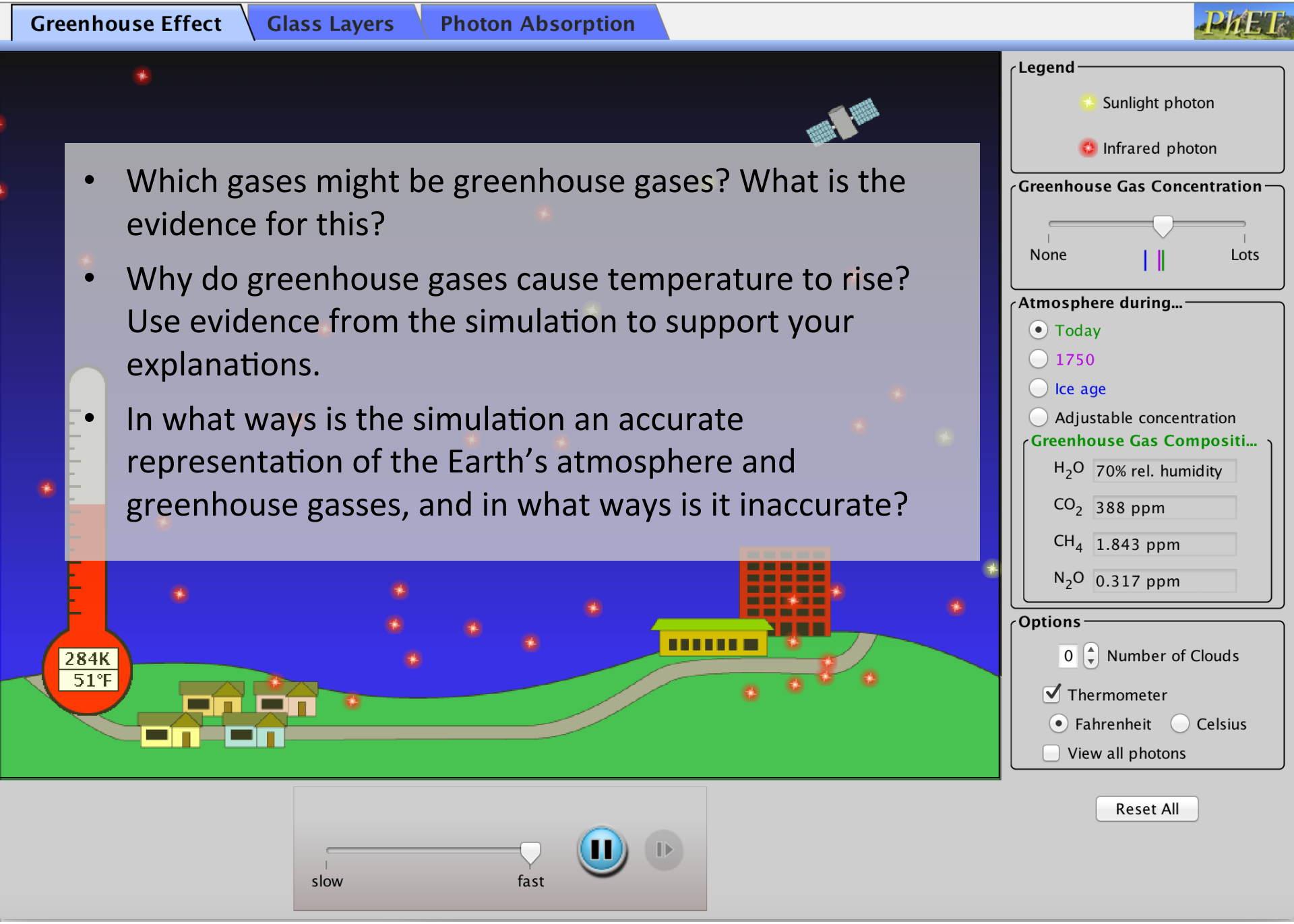
- Predictions
- Diagrams
- Questions

What would you say if you were going to "publish your findings" about the greenhouse effect right now? How would you explain your findings?


Greenhouse Effect
Glass Layers
Photon Absorption
PhET
https://phet.colorado.edu/en/simulation/greenhouse
Legend
Sunlight photon
Infrared photon
Greenhouse Gas Concentration
None
Lots
Atmosphere during...
Today
1750
Ice age
Adjustable concentration
Greenhouse Gas Compositi...
H_2O 70% rel. humidity
CO_2 388 ppm
CH_4 1.843 ppm
N_2O 0.317 ppm
Options
0 Number of Clouds
Thermometer
Fahrenheit
Celsius
View all photons
284K
51°F
slow
fast
Reset All

Consider the images

- What are the images displaying or representing?
- Which of these images are you finding helpful to understand the greenhouse effect?
- What did you discuss about each of the images? What questions arise for you as you look through the images?
- What do you want and need more information about?


Greenhouse Effect
Glass Layers
Photon Absorption
PhET
Which gases might be greenhouse gases? What is the evidence for this?
Why do greenhouse gases cause temperature to rise? Use evidence from the simulation to support your explanations.
In what ways is the simulation an accurate representation of the Earth's atmosphere and greenhouse gasses, and in what ways is it inaccurate?
284K
51°F
Legend
Sunlight photon
Infrared photon
Greenhouse Gas Concentration
None
Lots
Atmosphere during...
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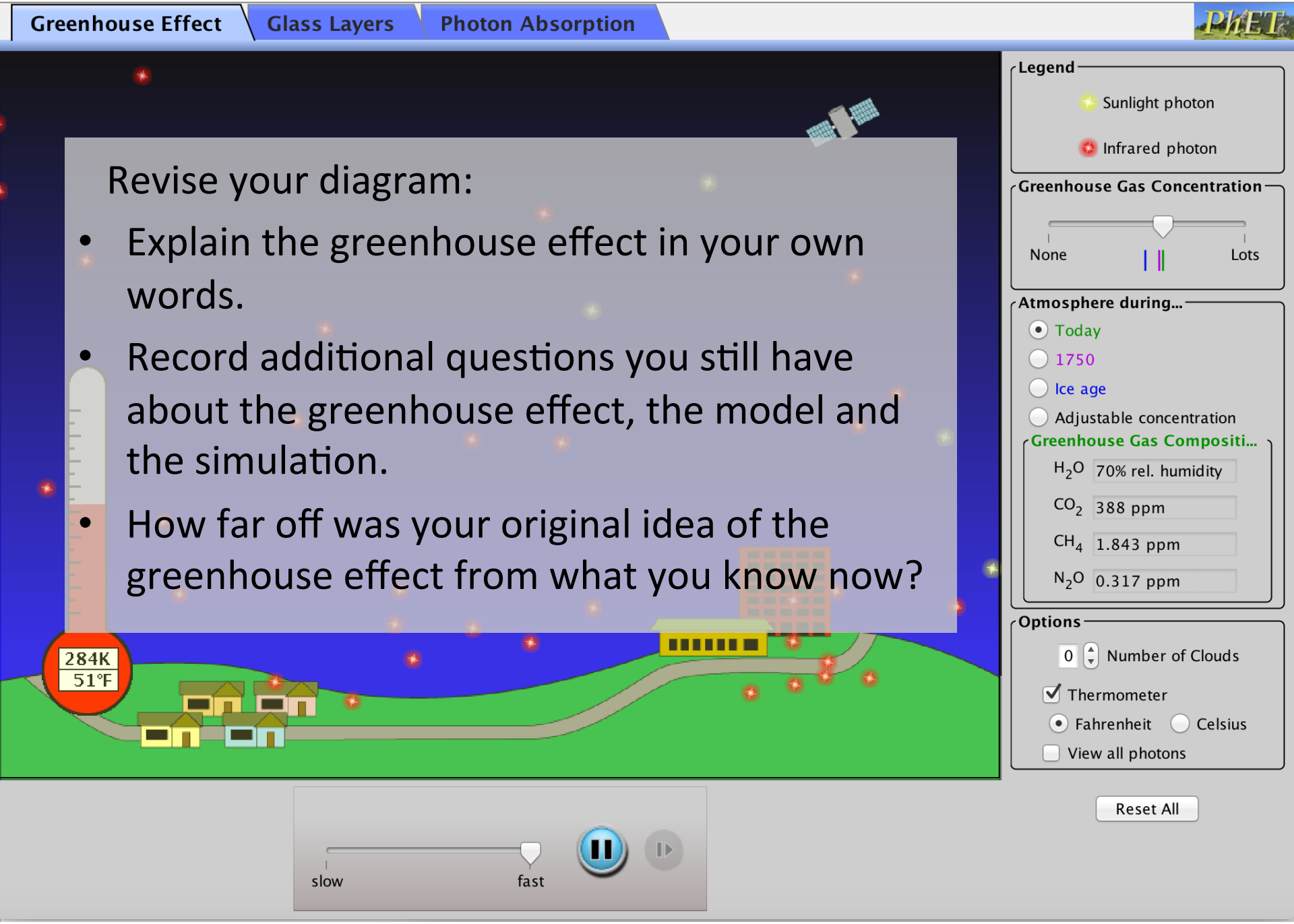
Greenhouse Effect
Glass Layers
Photon Absorption
PhET
Revise your diagram:
• Explain the greenhouse effect in your own words.
• Record additional questions you still have about the greenhouse effect, the model and the simulation.
• How far off was your original idea of the greenhouse effect from what you know now?
284K
51°F
Legend
Sunlight photon
Infrared photon
Greenhouse Gas Concentration
None
Lots
Atmosphere during...
Today
1750
Ice age
Adjustable concentration
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0 Number of Clouds
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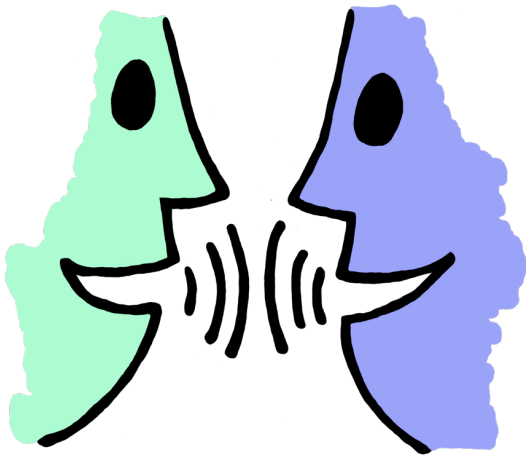
Fahrenheit
Celsius
View all photons
Reset All
slow
fast

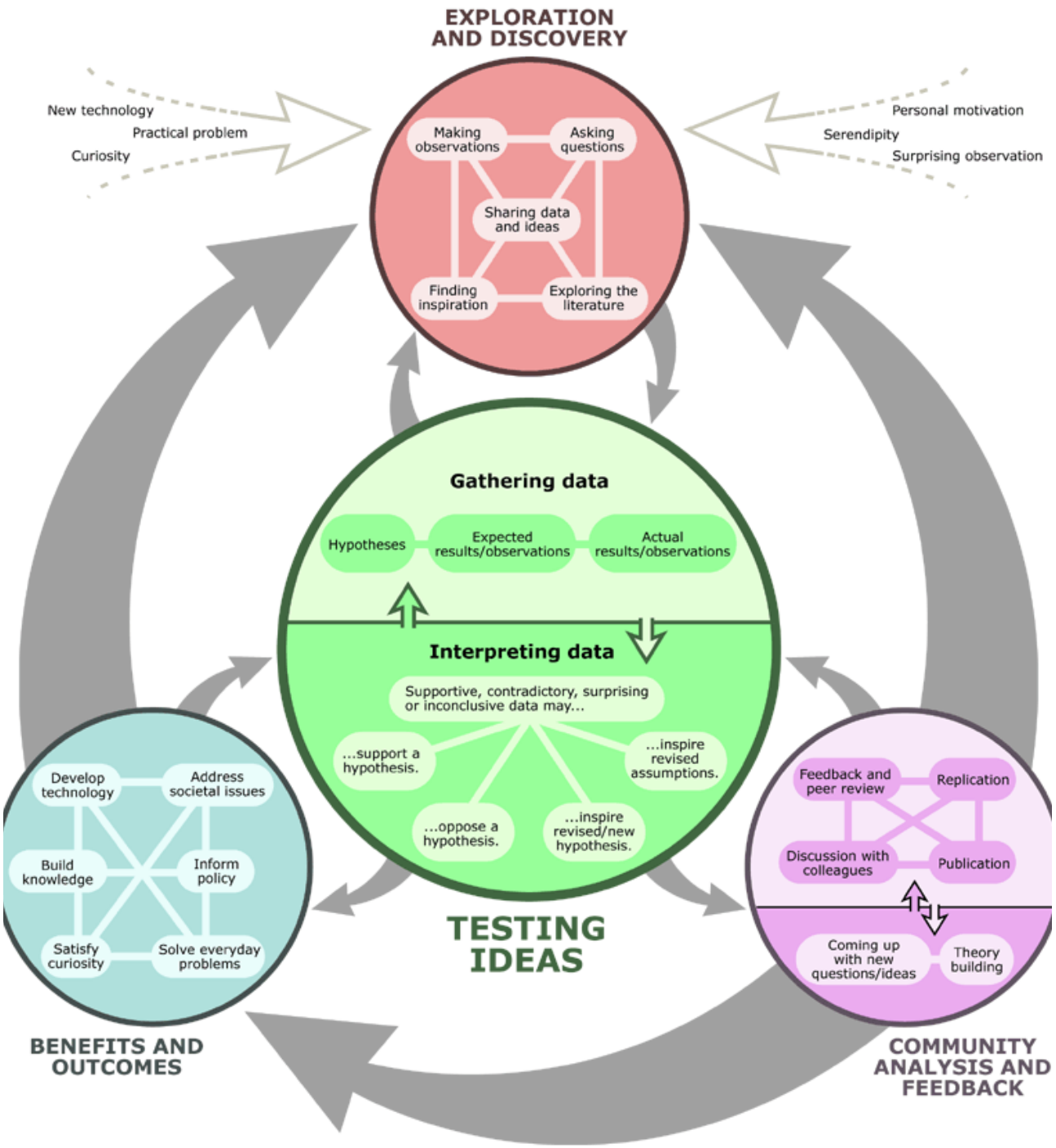
Synthesizing what we've figured out

- There is a relationship between Earth's atmosphere and temperatures on Earth.
- Earth's atmosphere contains heat-trapping gases, such as CO_2 and methane.
- Heat-trapping gases in the atmosphere trap the sun's heat energy.
- As CO_2 levels increase in the atmosphere, Earth's temperature rises.
- Heat-trapping gases (CO_2, CH_4, nitrous oxide, and water vapor) comprise less than 1 percent of Earth's atmosphere, but they make a large contribution to our planet's climate.
- Scientific evidence suggests that the main cause of rising CO_2 levels in the atmosphere over the last 200 years has been people burning fossil fuels.
- Earth's CO_2 level has increased and decreased quite a bit throughout Earth's history, but no known changes in the past 750,000 years have happened as quickly as this recent change.

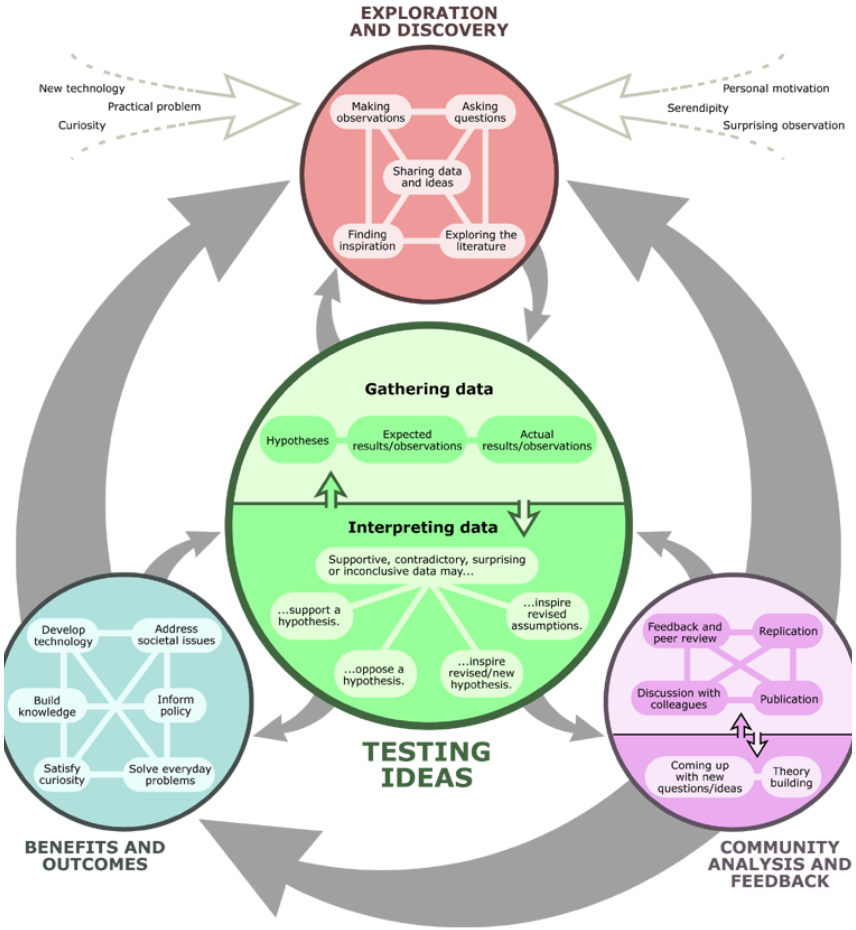
Turn and Talk



- What's one thing I might do or change to address the role that humans play in climate change?
- In what ways did my ideas change about the greenhouse effect?
- What helped me to change my ideas and to learn the concept?


EXPLORATION AND DISCOVERY
New technology
Practical problem
Curiosity
Personal motivation
Serendipity
Surprising observation
Making observations
Asking questions
Sharing data and ideas
Finding inspiration
Exploring the literature
Gathering data
Hypotheses
Expected results/observations
Actual results/observations
Interpreting data
Supportive, contradictory, surprising or inconclusive data may...
...support a hypothesis.
...inspire revised assumptions.
...oppose a hypothesis.
...inspire revised/new hypothesis.
TESTING IDEAS
Develop technology
Address societal issues
Build knowledge
Inform policy
Satisfy curiosity
Solve everyday problems
BENEFITS AND OUTCOMES
Feedback and peer review
Replication
Discussion with colleagues
Publication
Coming up with new questions/ideas
Theory building
COMMUNITY ANALYSIS AND FEEDBACK

What were all the things you did represented on the chart?



- What was the first thing you did in the activity?
- Where does it fit on the flow chart?
- Put a #1 in that section of the flow chart.
- Number the rest of the steps you took. Place numbers on the flow chart in the appropriate places.

Pair up and Compare

What are the similarities and differences between your flows?

How Science Works Flowchart

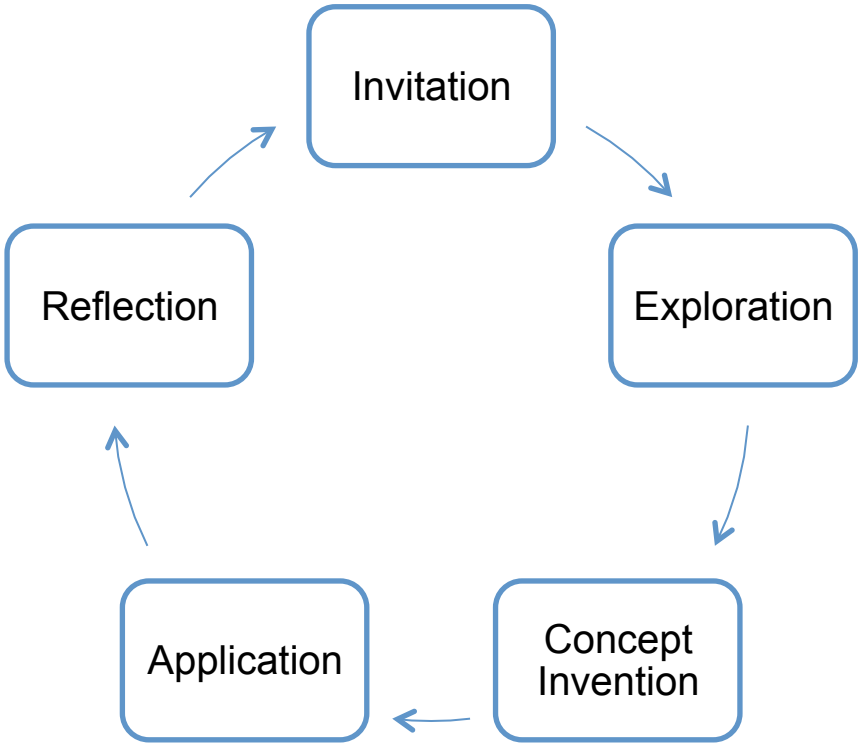
- What do you notice about your pathway shown on the flowchart?
- How does what you did in this activity differ from what you were taught about the science process in school?
- Which part(s) of the science process and practices shown on the flowchart did we address in this session (including the Mystery Tubes and our discussions)?
- Which part(s) did we not address?

Five Facets of Science Research Discussion

- Underline and star ideas that are interesting or surprising; make notes in the margin with your own thoughts.
- Circle ideas that are confusing or you do not agree with
- Write your questions and comments in the margin.
- When you finish reading, share your ideas with a partner.

Reflection

The Learning Cycle



Five Foundational Ideas

- Learning is ***an active process*** to construct understanding.
- Learning ***builds on prior knowledge***.
- Learning occurs ***in a complex social environment*** and is a social activity.
- Learning should be ***situated in an authentic context***.
- Learning is affected by ***motivation and cognitive engagement***.

- Which phases of the *learning cycle* were represented in the Greenhouse Effect activity? Be ready to support your answer with examples.
- Which of the *Five Foundational Ideas* were represented in the activity? What makes you think that?

Three Interviews

- Stand up with your notes and handouts, and mingle silently around the room until time is called. Then pair up with another person nearest to you.
- Share ideas with each other and each record something you heard from your partner.
- When time is called, mingle again, stop when time is called, and pair up with a new partner to share ideas again. Record something new, such as additional evidence or examples, and share something that's new to your partner.
- Repeat with a third partner.

- Which phases of the *learning cycle* were represented in the Greenhouse Effect activity? Be ready to support your answer with examples.
- Which of the *Five Foundational Ideas* were represented in the activity? What makes you think that?

Phase of the Learning Cycle	Greenhouse Effect Activity
Invitation	Looking at the climate change images and responding to questions: • What do you notice across the images? • What do you think is causing the phenomena shown in the images to happen? • What do you know about the cause(s) of climate change? Sketching diagram of current understanding of greenhouse effect and questions; introduction to the greenhouse in a bottle model; making predictions
Exploration	Doing the greenhouse in a bottle investigation; looking at the greenhouse effect-related images; using the Phet simulation
Concept Invention	Refining diagram of greenhouse effect and adding new questions; trying to explain the greenhouse in a bottle investigation; trying to explain how the pictures connect to the model; explaining new understanding based on Phet simulation; teacher shared final synthesis of information.
Application	What's one thing I might do or change to address the role that humans play in climate change?
Reflection	Revising greenhouse effect diagram and adding new questions throughout the activity. Considering how far off your new understanding of the greenhouse effect was from your original understanding. Answering the final reflection prompts: • In what ways did my ideas change about the greenhouse effect? • What helped me to change my ideas and to learn the concept?

Homework

- **Explore the UCMP Understanding Science website.** Visit the UCMP Understanding Science website http://undsci.berkeley.edu, and explore, including the Misconceptions about Science page http://undsci.berkeley.edu/teaching/misconceptions.php.
- **Read from the *Framework for K–12 Science Education* and respond to prompts.** Read pp. 78-79 "Reflecting on the Practices." Respond to the reflection prompts:
  - –What did you find interesting/surprising? What do you think would be interesting/surprising to middle school students or the general public?
  - –In what ways has your understanding of the nature and practices of science deepened?
  - –Describe why it is important to include the nature of sciences in science instruction.
  - –What questions were raised for you or what do you wonder about based on reading the Five Facets of Science during class?