Unit 7.2 Chemical Reaction and Energy

Content Area: **Science**
Course(s): **Science 7**
Time Period: **Marking Period 3**
Length: **MP 3**
Status: **Published**

Essential Questions

Lesson 1 How can we heat up food when we don't have our typical methods available?

Lesson 2 How do heaters get warm without a flame?

Lesson 3 What other chemical reactions could we use to heat up food?

Lesson 4 How much of each reactant should we include in our homemade flameless heater?

Lesson 5 How can we refine our criteria and constraints?

Lesson 6 How can we redesign our homemade flameless heater?

Lesson 7 How did our design compare to others in the class?

Lesson 8 What effects might result from our design changes?

Lesson 9 What is our optimal design for a homemade flameless heater?

Lesson 10 How can we decide between competing designs?

Big Ideas

In this 21-day unit, students are introduced to the anchoring phenomenon—a flameless heater in a Meal, Ready-to-Eat (MRE) that provides hot food to people by just adding water. In the first lesson set, students explore the inside of an MRE flameless heater, then do investigations to collect evidence to support the idea that this heater and another type of flameless heater (a single-use hand warmer) are undergoing chemical reactions as they get warm. Students have an opportunity to reflect on the engineering design process, defining stakeholders, and refining the criteria and constraints for the design solution.

In the second lesson set, students develop their design solutions by investigating how much food and reactants they should include in their homemade heater designs and go through a series of iterative testing and redesigning. This iterative design cycle includes peer feedback, consideration of design modification consequences, and analysis of impacts on stakeholders. Finally, students optimize their designs and have another team test their homemade heater instructions.

Anchoring Phenomenon

For the anchoring phenomenon, students begin by thinking about how they would heat up food without having typical methods available. They see images from a real situation, after Superstorm Sandy in New York, during which people were given Meals, Ready-to-Eat (MREs) that can heat up food by just adding water. The class explores the flameless heater from the MRE in action, which seems like some kind of chemical process or possibly a chemical reaction. Students develop an initial model to consider how a flameless heater works, but they also notice some problems with prepackaged MREs. In order to solve some of the identified problems, the class decides to help people in situations in which typical heating methods aren’t available to heat up food by designing a homemade flameless heater with instructions that others could follow.

Each OpenScied unit’s anchoring phenomenon is chosen from a group of possible phenomena after analyzing student interest survey results and consulting with several external advisory panels. The MRE flameless heater was chosen to anchor this unit for the following reasons:

- Homemade Heater Unit directly builds upon Disciplinary Core Ideas from grades 6-8 regarding chemical reactions OpenSciEd Unit 7.1: How can we make something new that was not there before? (Bath Bombs Unit), which comes just prior to this unit in the OpenSciEd Scope and Sequence. Students leverage their ideas about chemical reactions to figure out that energy transfer happens when substances undergo chemical reactions. It also builds directly upon the Disciplinary Core Ideas (DCIs) from OpenSciEd Unit 6.2: How can containers keep stuff from warming up or cooling down? (Cup Design Unit) as we use the model developed hete about energy transfer at the particle level to build a systems level model of energy transfer on which to base our homemade flameless heater designs.
- This unit includes a substantial engineering component with multiple iterations on design. Designing any device in the classroom can be costly and material intensive, but designing the instructions for a homemade flameless heater allowed for fewer specialized materials and an easier design process compared to other options.
- In thinking about who they may be helping with this homemade flameless heater, students realize that anyone in their community (including their own family and friends) are also the stakeholders and could potentially need to use an MRE at some point. Feedback from the field test indicated that students identified with the need for a device that could warm food as they reflected on times they lost power for extended periods of time due to snow storms, floods, or other large scale power losses.
- This anchor gives students to engage directly with the community about what they are learning, and an authentic opportunity to get stakeholder feedback. Students survey family, friends and other members of the community to get some initial ideas about the experience people have with MREs, any other initial ideas or questions, as well as feedback on designs and instructions.

Science and Engineering Practices

Asking Questions and Defining Problems

- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

Developing and Using Models

- Develop and use a model to describe phenomena. (MS-ESS2-6)

Planning and Carrying Out Investigations

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

- Open Sci Ed Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions

Cross-Curricular Integration

Integration Area: Language Arts

W.IW.7.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

A. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aid in comprehension.

B. Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples.

C. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.

D. Use precise language and domain/ grade-level- specific vocabulary to inform about or explain the topic.

E. Establish and maintain a formal style academic style, approach, and form.

F. Provide a concluding statement or section (e.g., sentence, part of a paragraph, paragraph, or multiple paragraphs) that follows the flow of ideas, reflects back on the topic, and supports the information or explanation presented.

Activity:

Students will write CERs (Claim, Evidence & Reason) on Climate Change. Students will be able to convey their thinking and decision making in written form.

- Students will be answering the question, “What are the contributors of climate change?”
- Students provide evidence that supports their claim.
- Students will then write a reasoning that explains what their claim is, state knowledge they have on the topic, evidence to prove their topic, and close their reasoning with their claim again.

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RL.CR.7.1. Cite several pieces of textual evidence and make relevant connections to support analysis of what a literary text says explicitly as well as inferences drawn from the text.

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RL.CI.7.2. Determine a theme in a literary text (e.g., stories, plays or poetry) and explain how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

RI.CI.7.2. Determine a central idea in an informational text and explain how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

RL.IT.7.3. Analyze how particular elements of a text interact including how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.

RL.MF.7.6. Compare and contrast texts (e.g., a written story, drama, or poem) to its audio, filmed, staged, or multimedia version and analyze the unique qualities of different mediums, including the effects of techniques unique to each medium (e.g., lighting, sound, color, or camera focus and angles in a film).

Activity:

Weather: Explain both the greenhouse effect and the theory of global warming. Do you believe there is a relationship between the greenhouse effect and global warming? Use at least three sources of evidence to support your claim. What impact, if any, does global warming have on your life? Be sure to include at least two relevant examples from your personal experience. What impact do these two things have on your life? Write an explanatory essay that uses fact, details and examples to explain each theory and their relationship to each other.

Chapter 6: Percents

7.RP.A.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.

Enduring Understandings

NGSS Performance Expectations (PEs):

- MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
- MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process so that an optimal design can be achieved.

Disciplinary Core Ideas

This unit expands students' understanding of energy in chemical reactions in the context of engineering design. These are the Grades 6-8 DCI elements:

PS1.B: Chemical Reactions

- Some chemical reactions release energy, while others store energy.

ETS1.B: Developing Possible Solutions

- Models of all kinds are important for testing solutions.
- A solution needs to be tested and then modified on the basis of the test results in order to improve it.
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design.

- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

You can view the placement of this OpenSciEd Unit 7.2 and associated units within the OpenSciEd Scope and Sequence document.

Crosscutting Concepts

- System and System Models
- Matter and Energy

CSDT Technology Integration

8.1.8.A.1	Demonstrate knowledge of a real world problem using digital tools.
8.1.8.A.4	Graph and calculate data within a spreadsheet and present a summary of the results.

Activity:

Students record the weather outside on a spreadsheet, using materials created in the classroom or provided by the STEM lab and compare them to reports of previous years. The data from the previous years will be researched from internet sources. The data from this year and the data from 20, 40, 60, 80, and 100 years ago will be placed on a table and will also require a creation of a graph indicating temperatures over the years. Students will explain how the climate has changed over the course of 100 years.

Climate Change

MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

- Activity: Develop and explain a model that describes the cycling of water throughout the system, driven by energy from the sun and the force of gravity. Create a detailed diagram of the water cycle, including labels for each process (Evaporation, condensation, precipitation, transpiration, and runoff). Write a short explanation (1-2 paragraphs) describing how the sun's energy and gravity drive these processes. Students will also include how climate change effects the water cycle.

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

- Activity: Collect and analyze data to explain how the motions and interactions of air masses result in changes in weather conditions. Create a weather forecast presentation that includes: 1. A map showing the movement of air masses. 2. Predictions of weather changes based on air mass interactions. 3. An explanation of how they used data to make their predictions. 4. A discussion of the probabilistic nature of weather forecasting.

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

- Activity: Develop and use a model to explain how unequal heating and Earth's rotation create patterns of atmospheric and oceanic circulation that determine regional climates. Create a digital or physical model demonstrating Earth's atmospheric and oceanic circulation patterns. Write a brief explanation (1-2 paragraphs) describing how these patterns are influenced by unequal heating and Earth's rotation, and how they can affect regional climates. Students could look at the past 5 years of hurricane activity in a specific area of their choice. Students can predict the trends for the next few years.

MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused climate change over the past century.

- Activity: Analyze the evidence of human activities contributing to climate change, explain the role of greenhouse gases in global warming, and evaluate potential solutions to mitigate climate change impacts. Create a digital presentation or poster that: (1) Identifies at least 3 human activities contributing to climate change. (2) Explains how these activities release greenhouse gases. (3) Presents evidence of global warming over the past century. (4) Proposes two realistic solutions to reduce human impact on climate change. (5) Includes a brief explanation of how their proposed solutions could help mitigate climate change.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

- Activity: Define the criteria and constraints for designing a climate-resilient community, considering scientific principles, potential impacts on people, and the natural environment. Students can be assessed by Create a detailed proposal for a climate-resilient community design. The proposal should include: (1) A list of a least 5 criteria for the design (e.g., energy efficiency, flood protection, heat mitigation). (2) A list of a least 5 constraints (e.g., budget, available materials, local regulations). (3) An explanation of how each criterion and constraint relates to scientific principles of weather and climate. (4) A discussion of potential impacts on different population groups and the natural environment. (5) A sketch or diagram of the proposed community design.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- Activity: Analyze and compare multiple design solutions for climate change mitigation, identify the best characteristics of each, and combine them to create an improved solution using data analysis and the Pythagorean theorem. Design, test, and evaluate three different solutions for reducing carbon emissions in their local community. They can collect data on each solution's effectiveness, use the Pythagorean theorem to calculate the impact on population distribution, and create a final report that: (1) Analyzes the data from each solution. (2) Identifies the best characteristics of each design. (3) Proposes a new, optimized solution that combines the best elements. (4) Justifies their choices using data and mathematical calculations.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool or process such that an optimal design can be achieved.

- Activity: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process to achieve an optimal design related to climate change mitigation. Design a simple wind turbine model using readily available materials (e.g., paper, cardboard, straws). They will then test their model, collect data on its performance, modify the design based on test results, and repeat the process to optimize their wind turbine's efficiency. Students will submit a report detailing their initial design, test results, modifications, and final optimized design, along with a graph showing the improvement in performance over iterations.

Career Readiness

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross-cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

- Activity: Gather, evaluate, and analyze data from diverse sources on the causes of climate change, considering global perspectives, and use this information to design multiple potential solutions. Create a multimedia presentation that: (1) Showcases data collected from at least three diverse sources representing different cultural, gender, or generational perspectives on climate change causes. (2) Evaluates the credibility and relevance of each source. (3) Synthesizes the information to propose two innovative solutions to address climate change. (4) Explains how the diverse perspectives influenced their proposed solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change and use critical thinking skills to predict which one(s) are likely to be effective.

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).

- Activity: Evaluate multiple solutions to a local or global problem, such as climate change, and use critical thinking skills to predict which solution(s) are likely to be most effective in both the short and long term. Create a presentation comparing and contrasting three different solutions to a chosen local or global problem. Evaluate each solution's potential effectiveness in the short and long term, considering factors such as feasibility, cost, and environmental impact. Students will then use critical thinking skills to predict which solution is likely to be most effective and explain their reasoning.

9.4.8.DC.8: Explain how communities use data and technology to develop measures to respond to effects of climate change (e.g., smart cities).

- Activity: Students may be able to evaluate sources of information for accuracy and relevance, apply deliberate search strategies to access high-quality information on climate change, and use information from diverse sources for a specific purpose. Students can be assessed by creating a research portfolio on a specific aspect of climate change. The portfolio will include: (1) A list of at least 5 diverse, high-quality sources. (2) A brief evaluation of each source's accuracy and relevance (3) A summary of the search strategies used to find the sources (4) A 2-page report synthesizing the information for a specific purpose (e.g., informing local policymakers about climate change impacts)

Resources

Savvas Interactive Science - Water and Atmosphere - 2016

Scientific Inquiry

MS-ESS2-4 *Water Cycle in a Jar*
MS-ESS2-5 *Weather Scope Real Time Data*
MS- ESS3-5 *Which Location is Best for Me*