

5E LESSON PLAN: STEM**TOPIC**

Heat and Heat Transfer

TITLE

Engineering Project- Thermos Design

UNIT

Chemical Interactions

GRADE LEVEL

8th Grade

NGSS STANDARDS**SCIENCE**

MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS1-4.: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

ENGINEERING

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 difference among several design solutions to identify the best characteristics of each that can be combined into a new solutions to better meet the criteria for success.

MS-ETS 1-4. 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.

COMMON CORE STANDARDS

3.2.8.B3: Explain how changes in temperature are accompanied by changes in kinetic energy.

3.2.8.B4: Compare and contrast atomic properties of conductors and insulators.

KNOWLEDGE OF LANGUAGECCSS.ELA-LITERACY.L.8.3

Use knowledge of language and its conventions when writing, speaking, reading, or listening.

CCSS.ELA-LITERACY.L.8.3.A

Use verbs in the active and passive voice and in the conditional and subjunctive mood to achieve particular effects (e.g., emphasizing the actor or the action; expressing uncertainty or describing a state contrary to fact).

MATHCCSS.MATH.CONTENT.HSA.REI.A.2

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

CROSSCUTTING CONCEPTS

- **Patterns:** Patterns can be used to identify cause and effect relationships.
- **Systems and System Models:** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
- **Energy and Matter :** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). The transfer of energy can be tracked as energy flows through a designed or natural system.
- **Stability and Change:** Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.

SET UP: PLACE AND TIME

The activity will take place on the school campus and it will take 9 days with students given one period each day of class time in Science(period = 60 minutes).

BACKGROUND

So far in the unit students have been acquiring knowledge on energy and how it is transferred. They have been gaining understanding in matter and the forms it can take. Both of these topics has lead to heat energy and the way that it is transferred. Heat is a form of energy in which kinetic energy is gained or lost in a system. Endothermic energy is when heat is absorbed and transferred into a system and Exothermic energy is when it leave a system. Through this phenomenon a substance becomes “hot” or “cold”. Heat is produced by molecules moving faster in a system and colliding into each other. This movement is kinetic energy. How can we keep a closed system at a given level of kinetic energy and therefore heat for an extended period of time? This is the problem society has for keeping a beverage hot or cold. A thermos is a cup design in which the energy is contained for an extended period of time. This is due to the insulator and design of the cup. Students will also discuss the differences in heat and temperature throughout this unit.

JUSTIFICATION

This lesson is a section within the unit on Chemical Interactions and has students creating their own thermos for hot liquids. The purpose is to demonstrate to students the use of STEM knowledge and skills in the real world. The entire engineering project is presented to students as a company scenario. I, the instructor, am the CEO of the company and divide the workers (students) into project teams. The teams have to research, design, construct, test, modify, test again, and then present their final product. The team that has the best design (judged based on rubric) will receive a bonus (bonus point). This project is a great way for students to apply their knowledge on heat transfer, kinetic energy, and matter. It is also a way for students to learn multiple skills and showcase their own talents. The integration of all the different content areas enhances student understanding in each subject. Students are not only using science, technology, engineering, and math, but other subjects as well. Science can be seen in the background knowledge, research, lab techniques, and discussion on heat transfer. Technology in the review game and research for the thermos design. Engineering in the design process itself. Math in student blueprints for the thermos. Students measure circumference, length, and width of their thermos. Groups also calculate heat loss through calories for each trail. Other content areas are used as well, such as, English Language Arts, Art, and Music. To present students are able to create PowerPoints, logos, and other imaginative ways to showcase their product. The assignment in itself can also easily be modified for lower and higher ability classes. Aspects of the lesson can be shortened or given more tasks depending on the class.

OBJECTIVES

- Students will be able to understand that insulating materials reduce energy transfer via conduction. Materials with more widely spaced particles serve as better insulators.
- Students will be able to solve problems that meet a set of criteria and that work within the constraints of the problem.

- Students determine criteria and constraints in the engineering design process and test their designs.
- Students use their understanding of energy transfer to face an engineering problem: how to build a container that keeps hot liquids hot. They test materials for their insulating properties in preparation for the design challenge.
- Students will be able to recall and explain that energy always transfers from particles with more kinetic energy to particles with less kinetic energy. Energy is conserved. The amount of energy in a system does not change—no energy is ever created, and no energy is ever destroyed.
- Students will be able to define Temperature as a measure of the average kinetic energy of the particles of a substance. Heat (energy transfer) is measured in calories. One calorie is the amount of heat needed to raise the temperature of 1 mL of water 1 degree Celcius.
- Students will be able to calculate calories and how many were lost or gained in their thermos design.
- Students will be able to work in a collaborative setting to design and test a thermos of their own creation.
- Students will be able to present a PowerPoint presentation to persuade their peers to buy their design.

MATERIALS

- Powerpoint (Instructor)
- FOSS Resource book (1 per pair of students)
- Lab Composition Book (each student)
- Scrap paper (brainstorming)
- Graph paper (blueprint)
- Ruler (2 per group)
- Black sharpy (2 per group)
- Plastic Outer cup (500mL) (1 per group)
- Plastic Inner cup (250mL) (1 per group)
- 50 mL hot water (80°C) (for each group)
- Insulation material (students bring in, but the instructor should also supply some just in case (towels, foam, newspaper, and foam plates are just some examples))
- Masking tape (1 roll per group)
- Thermometer (2 per group)
- Rubric (1 per group)
- Student checklist/procedure (1 per group)
- Chromebook (Presentation) (2 per group)
- Poster board (Logo) (1 per group)

- Markers (Logo) (1 set per group)

PROCEDURE (Based on the 5Es)

ENGAGE

(The purpose for the ENGAGE stage is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.)

Day 1: The lesson will start by grabbing the interest of students from the knowledge gained in the prior lesson. Before this engineering design the class discussed energy, energy transfer, and more specifically heat energy. The instructor should review what was learned in this lesson by asking students questions through a game called kahoot.

<https://create.kahoot.it/details/investigation-4/979692bf-b212-425d-8476-849585565be5>

The game is based on lesson 4 in the unit on Chemical Interactions. The instructor can sign up for free and use the website to create questions and answers. Students then use ipads or laptops to compete against each other and answer the questions. Whoever gets the most answer correct the quickest wins! That students will receive a prize (in this lesson the student will receive a mint candy).

Once the game is over the instructor will go over a couple more questions leading into heat transfer. Students will have to think about heat at a particle level and how the particles move. The instructor will then pose a couple questions:

- How can we slow a particle down?
- How can we speed a particle up?
- What could we do or use to keep a particle at a particular rate or at a certain temperature?
- What kind of materials could keep a substance, lets say a liquid, at a certain temperature?
- What kind of product is used to keep a liquid hot?

These questions will lead into the discussion of thermoses. The class will then discuss how a thermos works. This will bring up the subject of insulators and conductors.

Students will be given a list of materials in the classroom and asked to place them in two columns insulator or conductor. Students will then get into pairs with the chromebooks and access <https://scratch.mit.edu/projects/92665956/#fullscreen> this is an online simulation where students will close a circuit using the same list of materials.

Wood	Fork	Glass Plate	Cork	Eraser
Brick	Nail	Coin	Metal Sheet	
Soap	Paper	Sharpener		

Students are asked to go home and look through their cabinets to see if they own a thermos. They should record the brand and features of the thermos or bring it into class tomorrow.

EXPLORE

(The purpose for the EXPLORE stage is to get students involved in the topic; providing them with a chance to build their own understanding.)

Day 2: The following day in class students have brought in their information on thermoses or brought in one. (This was not required and there is not a grade). Students will stand and share some information about the thermos that they have at home. If there was one brought in they will pass it around the room. The instructor will then click on the powerpoint at the front of the room to display the focus question. Students will have 2 minutes to answer in their composition books.

Focus question: Name at least 4 materials that are used for insulation. Which material would you pick to hold heat in a liquid like water?

Once the two minutes are up the instructor will begin introducing insulators and conductors. The class will go around the room with volunteers to talk about insulators and conductors that they know of. Students will also have their resource books open to look at the periodic table to name some more.

The instructor will pose further research into thermoses and how they work. Students will be given a worksheet with questions and instructions to help guide them through the research online. Students will be working in pairs in their lab groups (Lab groups are made up of 3 or 4 students). *Worksheet example is provided below:*

Names: _____

Date: _____

Searching for the Best Thermos

Directions: In your lab group pick a partner to work with (If you are in a group of three all three may work together or one person can work by themselves). Use the internet to look up the following questions about thermoses, insulators, and conductors. Follow all directions and have completed by the end of class.

1. What is the difference between an insulator and a conductor?
2. What is a thermos used for?

3. What are the top 3 companies that make thermoses?
 4. How does a thermos work?
 5. How does a vacuum hold the heat for a thermos?
 6. Name at least 3 different materials used inside a thermos.
 7. Draw a diagram of a thermos below from a company of your choosing. Be sure to say the company, give the measurements of the thermos, and label the materials. Also include the features of the thermos on the side.
 8. If you had to create a name for a thermos company what would it be?
-

The class will then go over the worksheet and what they found. The instructor can also add other information for the students to look up to get them engaged. For example, what is the most expensive thermos? Students will put away chromebooks and sit with their lab group. At this point all 3 or 4 students are sitting together to work. The instructor will give students a little bit of insight on what their project is going to be to give them time to brainstorm their materials. The instructor will ask students:

If you were to design a thermos yourself in this classroom with your lab group what material would you use? Think of household items that you could bring in. Generate a list of at least 5 things and narrow it down to 1. The material has to fit between two cups. The larger cup is 500mL and the smaller cup inside is 250mL. The material must fit between the two cups.

Lab groups will be given one of each cup to look at as they brainstorm. Students will be asked to keep their ideas for class tomorrow in their composition books.

Examples of some of the insulation materials (the instructor can suggest these if the students are stuck)

- Insulation (house)

- Newspaper
- Foam
- Towels
- Foil
- Paper
- Cardboard

Finally, prior to the bell, the class will discuss the engineering project design and how they use it in their everyday life. This image will be shown on the board:



An example that could be used by the instructor:

selecting shampoo and conditioner.

Day 3: In the next lesson the instructor will start by explaining the directions for the project. Students will then have time to work on their design and at the end they will answer questions about heat transfer.

The directions are explained by the instructor both orally and in written form on a powerpoint for students. Students can refer to the powerpoint at anypoint during class and outside of class. the powerpoint is shared with all students in a common folder on google drive. The project will go as follows:

1. After reviews and discussions students have brainstormed insulation materials that would fit between a 500mL and 250mL cup. With these materials in mind students will begin to consider their design for the thermos.
2. The instructor will introduce the project as a company project, “Welcome to the FOSS company. I am your CEO aka your boss. I have divided you up into project teams. Each team will design, construct, test, and present a thermos of their own creation. These

presentations will need to have the design, product, logo, and oral presentation. Within 5 days each project team will present for the board. I will choose the best design based on effectiveness of the design and presentation. The project team will get a bonus at the end of the quarter (aka you all get a bonus point at the end of the marking period). Today you will begin designing with your team. You must agree on your design and work together to complete. Graphing paper, the thermos cups, and rulers are provided. Examples are provided hanging around the room if you need assistance. You have 35 minutes to work on the design together in class. Come into the office tomorrow with your design and material ready to construct”.

3. The instructor should take questions at this time and ask students questions to be sure they understand.
4. Students can begin and walk around the room as needed. The instructor should be able to observe collaboration, critical thinking, relative arguments, and progress.
5. Once the 35 minutes is up students are asked to clean up and return to their seats.
6. The instructor will then pass out an exit slip on heat transfer and this section of the unit.

Exit Slip: What happens to the particles in a liquid when they are heated to boiling point? Draw 3 images to explain.



Students will be reminded to bring down their materials in the morning the following day.

Criteria for the project will be taped to each lab table

Engineering Problem

A drink-container company, FOSS, wants to design a new container that can keep hot liquids hot. They have the shell (the outer and inner walls), but they want to know how to most effectively reduce the transfer of energy between the surrounding atmosphere and the liquid within the container.

Criteria

- You must use the cups given in class
- Each group will have a chance to brainstorm materials. Materials can be supplied by the instructor or brought in from home.
 - *If brought in, the materials must already be at home, not newly bought*

- Each group will select a material and no other groups may use this material once selected. *(Make a list of your top 3 in case yours is taken; see me if there is an issue)*
- The constructing and testing will be done in class.
- Measure the heat loss in the thermos over different increments of time (5, 10, and 20 minutes) Calculate calorie for the heat loss.

Your Company Project

1. Create a company name
2. Design your insulating cup (Graph paper given)
 - a. Draw out your design
 - b. Include labels and sizes for you cup (rulers in the back if needed)
2. Create a name for your cup design

The company and cup name should be on the graph paper as well. This will be turned in at the end of the lab. Make sure to have everyone in your groups names on it.

Presentation of Project

Criteria:

- Give your company name and the name of your product
- Show your design (to be turned in when your finish)
- Demonstrate your design
- Explain why it is the best design and why the company should pick your team

Rubrics for the project will also be given to each lab group for reference

Investigation 6.1 Engineering Problem 1

Rubric

Engaged in the construction and design of product (Participation)	5	4	3	2	1
Product design: measurements, insulator, and	5	4	3	2	1

materials					
Accuracy of design compared to the constructed product	5	4	3	2	1
Presentation of design	5	4	3	2	1
Heat transfer of product (Calories)	5	4	3	2	1
<i>Creativity (Extra Points)</i>			3	2	1

Participation will be observed by the instructor for the two days of the activity. This grade will be individual for each student.

The design of the product should include measurements of all materials, an illustration of the insulator, and a materials list.

The accuracy of design and constructed product- this refers to the blueprint design and the actual product created. Are they similar to each other in presentation. If a group wishes to change their product they must also changed their design on the graph paper.

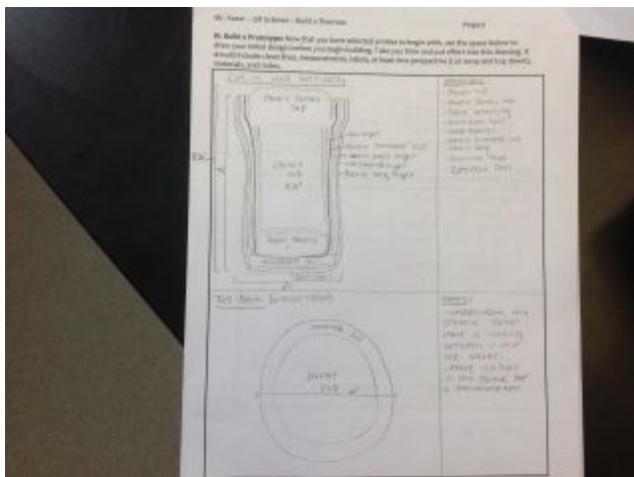
Presentation of design refers to the groups pitch of the product. They must show their product and discuss results.

Heat transfer of product is strictly the amount of heat loss or gain by the product within the 5 minute period. This will be graded by the instructor. If the design loses and gains heat in the 5 minutes or one of the cups keeps the heat in or out that groups will receive full points. Points will be lost with increases loss or gain of heat to the hot and cold water. The purpose is to keep the hot water hot and the cold water cold.

Creativity gives extra points to groups and individuals that go above and beyond on the project. This could refer to the names, design, and construction.

Total Points: 25 points

Examples shown around the room to help students with their blueprints:



Day 4: Students will have the class to work on their design and construct it. Materials should already be set up around the room. Student materials will be labeled by science section. Directions/rubrics/ and criteria will be posted for students to see. Students will be permitted to show the instructor blueprint for feedback. The instructor is to walk around with a clipboard and make informal observations (as if they were a CEO). The instructor can also ask students about their design as they go around. At the end of class students will place their design on the back table under their science section. The thermoses should be labeled by their lab number. Students are given 55 minutes of class time. If more is needed there should be a sign out sheet at the front of the room for the end of the day to come to the science lab. If there are too many students overflow will go to the tech room next door. If necessary, they can take their materials to another teachers' classroom with their permission.

Day 5: Students will enter the room and answer a focus question on the board in the composition book, "How does building a thermos relate to heat transfer?" Students are asked to reflect on the lesson and gain understanding on why they are doing the project in the first place. Once finished with the focus questions students are directed to begin their testing. Directions for testing will be displayed on the board for students to see. Each group is permitted 50mL of 80C water to test. When a new trial begins they will refill. Hot plates are provided to get accurate temperatures spread throughout the teams. Students are aware of supplies and where they are located throughout the room. They also have access to the rubric and criteria on their lab tables. Students will need to test the thermos using thermometer for 2 trials of 10 minutes and one trial of 20 minutes. Once all trials are completed students are asked to clean up and work on their presentation. Students then go back and use a skill gained in the previous investigation. Students will calculate calories; the loss of heat in their thermos. These measurements will be part of their data ($Q = m \Delta T$). Throughout the testing students are able to make modifications to their design and blueprints. The instructor will be around the room to make notes and ask questions.

Day 6: Students will have this day to retest, modify, and work on their designs. They will keep their same insulation, but they can add to it with other materials. This 60 minute class will be dedicate to students working in their lab groups. All materials will be available to students including the poster board and markers to work on their logos. At the beginning of the class the instructor should make suggestions to students, "It might be a good idea to divide and conquer. Which means it might be easier to divide up the work amongst group members". The goal of this is teach responsibility and teamwork within the groups. The instructor will continue to move around the room observing and asking questions. The instructor should be acting more like a coach in this situation.

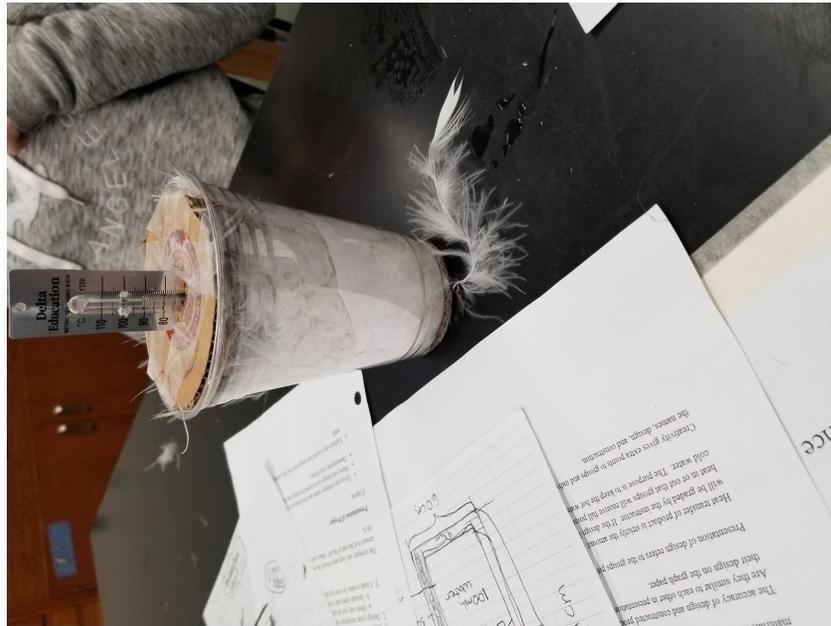
Day 7 and 8: The instructor will sign out the chromebooks so students have the opportunity to work on their PowerPoint presentations and logos. Students will be presenting their design the

following class. The instructor is available for guidance and questions. Students may also want feedback on their work thus far.

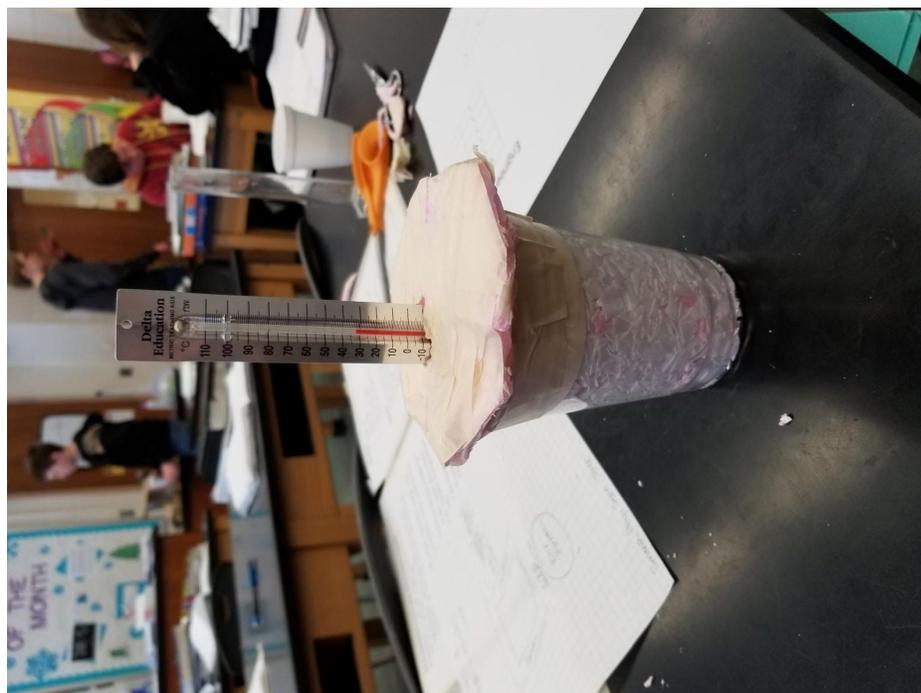
Day 9: Students will be presenting their designs with their lab groups. The instructor will move to the back of the room and write on the rubric as each group presents. Students will showcase their design, data, and conclusions on their project. They may also get creative with jingles, logos, commercials, and powerpoints. The presentation part of the project was created for students to think outside of the box with fewer guidelines to follow.

Below are some examples of thermos designs in a previous year:

Example 1



Example 2



Presentation Rubric:

PRESENTATION RUBRIC for PBL (for grades 6-8; Common Core ELA aligned)			
	Below Standard 1 Point	Approaching Standard 2 Points	At Standard 3 Points
Explanation of Ideas & Information	<ul style="list-style-type: none"> uses too few, inappropriate, or irrelevant descriptions, facts, details, or examples to support ideas 	<ul style="list-style-type: none"> uses some descriptions, facts, details, and examples that support ideas, but there may not be enough, or some are irrelevant 	<ul style="list-style-type: none"> uses relevant, well-chosen descriptions, facts, details, and examples to support claims, findings, arguments, or an answer to a Driving Question (CC 6-8.SL.4)
Organization	<ul style="list-style-type: none"> does not include important parts required in the presentation does not have a main idea or presents ideas in an order that does not make sense does not have an introduction and/or conclusion uses time poorly; the whole presentation, or a part of it, is too short or too long 	<ul style="list-style-type: none"> includes almost everything required in the presentation moves from one idea to the next, but main idea may not be clear or some ideas may be in the wrong order has an introduction and conclusion, but they are not effective generally times presentation well, but may spend too much or too little time on a topic, a/v aid, or idea 	<ul style="list-style-type: none"> includes everything required in the presentation states main idea and moves from one idea to the next in a logical order, emphasizing main points in a focused, coherent manner (CC 6-8.SL.4) has an effective introduction and conclusion organizes time well; no part of the presentation is rushed, too short or too long

<p>Eyes & Body</p>	<ul style="list-style-type: none"> • does not look at audience; reads notes or slides • does not use gestures or movements • lacks poise and confidence (fidgets, slouches, appears nervous) • wears clothing inappropriate for the occasion 	<ul style="list-style-type: none"> • makes infrequent eye contact; reads notes or slides most of the time • uses a few gestures or movements but they do not look natural • shows some poise and confidence (only a little fidgeting or nervous movement) • makes some attempt to wear clothing appropriate for the occasion 	<ul style="list-style-type: none"> • keeps eye contact with audience most of the time; only glances at notes or slides (CC 6-8.SL.4) • uses natural gestures and movements • looks poised and confident • wears clothing appropriate for the occasion
<p>Voice</p>	<ul style="list-style-type: none"> • mumbles or speaks too quickly or slowly • speaks too softly to be understood • frequently uses “filler” words (“uh, um, so, and, like, etc.”) • does not speak appropriately for the context and task (may be too informal, use slang) 	<ul style="list-style-type: none"> • speaks clearly most of the time; sometimes too quickly or slowly • speaks loudly enough for most of the audience to hear, but may speak in a monotone • occasionally uses filler words • tries to speak appropriately for the context and task 	<ul style="list-style-type: none"> • speaks clearly; not too quickly or slowly (CC 6-8.SL.4) • speaks loudly enough for everyone to hear; changes tone to maintain interest (CC 6-8.SL.4) • rarely uses filler words • speaks appropriately for the context and task, demonstrating command of formal English when appropriate (CC 6-8.SL.6)
<p>Participation in Team Presentations</p>	<ul style="list-style-type: none"> • Not all team members participate; only one or two speak 	<ul style="list-style-type: none"> • All team members participate, but not equally 	<ul style="list-style-type: none"> • All team members participate for about the same length of time • All team members are able to answer questions about the topic as a whole, not just their part of it

Presentation: 15 points total**EXPLAIN**

(The purpose for the EXPLAIN stage is to provide students with an opportunity to communicate what they have learned so far and figure out what it means.)

Students have gone through the procedures of the design challenge. They have designed, constructed, tested, redesigned, and presented their thermoses. Students were given feedback and the chance to change their thermos. On the 10th day the instructor and the students will reflect on what they have learned. Students will fill out the reflection/analysis paper with the following questions:

- What were some strengths to your design?
- How did your design features relate to the function of the thermos
- How was heat transferred in your design?
- What was one thing you thought worked well for another group that you might want to add to your design?
- What changes are you thinking about trying and why?
- How did this project relate to “the real world”?
- What did you like about this project and what would you change if we were to do something like this again?

Once students have answered this questions in written form by themselves (15 minutes given). The instructor will ask students to pair up with someone not in their lab group and discuss their answers (15 minutes). The class will then come back together to discuss as a class their thoughts on the project. The instructor will then announce the project team for the company that will receive the bonus. Students will then be asked to take apart their designs and clean up all materials.

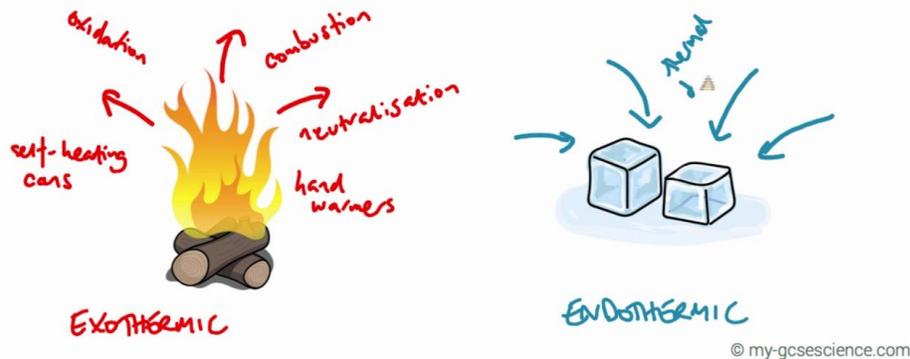
ELABORATE/EXTEND

(The purpose for the EXTEND stage is to allow students to use their new knowledge and continue to explore its implications.)

We will be extending this investigation after the following section. In investigation 8 the class will be conducting another engineering project, but this time designing freezers. Students will use their skills from this investigation on thermoses and preventing heat loss to preventing heat gain. This will continue our exploration of heat energy. (Optional: have the tech ed teacher join in on the next project to further interest in engineering).

Exothermic and endothermic reactions

Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place.



EVALUATE(The purpose for the EVALUATION stage is for both students and teachers to determine how much learning and understanding has taken place.)

Throughout the lesson students were observed and graded using a rubric by the instructor. The instructor kept track of participation and oral answers. This formative assessment will be used to provide students feedback during the process of the engineering project. Students will also see how feedback can be used to improve and by example provide feedback to each other.

Students are graded on the project both individually and as a group. Students have the chance to evaluate each other and themselves in the presentation section. Their reflections are also taken as an assessment towards the understanding of engineering by design. At the end of the next unit there is an I-check. An I-check is a product of FOSS (program used by the school). It is a formative assessment as a quiz in which students are given a chance to correct answers and turn it in again for half points.

Here is an example of the I-check. This one has been modified for an IEP.

Investigations 6-8 I-check

Name: _____

Chemical Interactions

Date: _____

1. The melting/freezing point of mercury is -39°C . A scientist put liquid mercury into a freezer that is kept at a constant temperature of -35°C .

Will the liquid mercury freeze? _____

Why or why not?

- a. ~~It will not freeze, because it is too cold for it to freeze~~
 - b. ~~It will freeze, because the freezer is the perfect temperature~~
 - c. It will freeze, because it is at its freezing point
 - d. It will not freeze, because the freezer is warmer than the freezing point
2. What is between the water particles in a glass of pure water?
- a. ~~Water particles~~
 - b. Hydrogen Atoms
 - c. Nothing
 - d. ~~Matter~~
3. When a substance changes from a liquid to a solid, which of the following is true?

_____ the particles change shape

_____ the particles change from soft to hard

_____ the particles are held more strongly to one another

_____ the particles have more kinetic energy

_____ the particles have less kinetic energy

_____ the substance is freezing

_____ the substance is melting

4. What is melting?
- a. Change from a solid to a liquid due to heat
 - b. Change from a gas to a liquid due to the lack of heat
 - c. ~~When a substance disappears into a liquid~~
 - d. ~~When a substance is ionized into a plasma~~
5. What is dissolving?
- a. ~~When a substance reaches its melting point~~
 - b. When a solid substance disappears into a liquid
 - c. When a solid turns into a gas because of heat

d. ~~A change from a gas to a solid~~

6. What is kinetic energy?

- a. Stored energy
- b. Energy of motion
- c. ~~Energy of frozen particles~~
- d. Energy in reserve

7. You wash a T-shirt. You hang the wet T-shirt on a clothesline. A few hours later, the T-shirt is dry. Mark an X next to each statement that explains what happens to the water particles after you hang the shirt up.

_____ the water particles are absorbed by the T-shirt

_____ the water particles evaporate into the air

_____ the water particles disappear and no longer exist

_____ the water particles melt into the T-shirt

_____ the water particles moved faster and become part of the air

_____ the water particles break down to hydrogen and oxygen particles and move into the air

8. What happens on a particle level when a liquid becomes a solid?

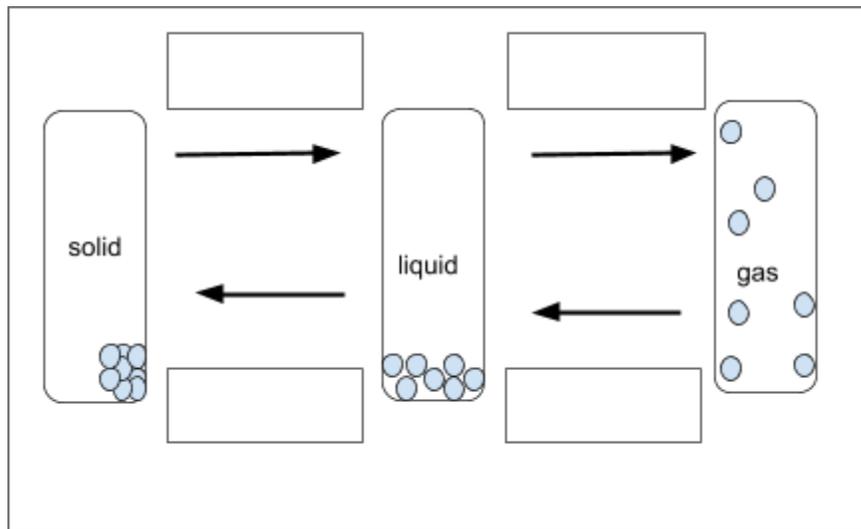
- a. The particles gain energy and spread farther apart
- b. ~~The particles lose energy and grow larger in size~~
- c. The particles lose energy and come closer together
- d. ~~The solid dissolves into the liquid~~

9. A student dissolved 20 grams of salt in a cup of water. She left the cup uncovered in an area where nobody could touch it. When she returned to the cup 10 days later, she would find that all the water was gone, and there were crystals in the bottom of the cup. What is the best conclusion, based on her observations.

- a. The water evaporated, and there is 20 grams of salt in the cup
- b. ~~The water and some salt evaporated, but some salt is left in the cup~~
- c. There was a chemical reaction, and the precipitate was left behind

- d. ~~The water and salt separated and then the water evaporated, but there is no way to know what is left in the cup~~

10. There are three vials of the same substance in the diagram: one solid, one liquid, one gas. In the four boxes above and below the arrows, write the name of the process that results in the phase change.



EVALUATE CONTINUED

Students will answer the Essential Question or Big Idea in their project teams. “How does insulating materials affect the transfer of thermal (heat) energy out of a “hot” system?” Students in each group will write their own answer then share with their group. The group will come up with one answer combining their own and nominate someone in the group to read it aloud.

These will then be turned into the instructor.

RESOURCES

5E’s lesson plan example. (shared 2018 by instructor). Climate and the Effects of Global Climate Change. Endeavor. Methods of STEM Education 2018.

Engineering by Design Process image

KQED Quest. (April 12, 2017). The Engineering Design Process: A Taco Party. Youtube. Received from: https://www.youtube.com/watch?v=MAhpfFt_mWM

Exothermic/Endothermic reaction image

myGCSEscience. (November 7, 2017). GCSE Chemistry Exothermic and endothermic reactions (OCR 9-1). Youtube. Received from: <https://www.youtube.com/watch?v=d6fl3U0rt4k>

FOSS. (2018). Full Options Science System. program can be found at <https://www.fossweb.com/>

Google Drive/ Google Classroom. (2018). <https://www.google.com/>

Kahoot!. (2018). Kahoot! A fun way to learn!. <https://kahoot.com/welcomeback/>