

[**Triad**](http://mysoe.net/triad/) **NGSS Unit Plan Tool**

**Triad Team Names:**

Science Cooperating Teachers: Cheryl Brewer, Jessica Powell

Science Educator: Dr. Horacio Ferriz

**School and District:** Hidahl Elementary and Sinclear Elementary, Ceres USD

**Grade Level:** 6

**Science Content Area:** Physical Science: Energy

**Unit Introduction**

This unit contains the following sections:

A. [NGSS, CCSS, and ELD Standards](#30j0zll)

B. [Content Research](#1fob9te)

C. Prerequisite Skills

D. Activities

E. [Summative Assessment](#3znysh7)

F. [The Unit Plan](#2et92p0)

G. [Lesson Support Materials/ Student Work Samples](#tyjcwt)

**A. Grade Level and Standard**

1. [California NGSS](http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp) Middle School standard

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.[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

**Three NGSS Dimensions Contained in the Standard:**

* + 1. **Science and Engineering Practice: [Planning and Carrying Out Investigations](http://www.nap.edu/openbook.php?record_id=13165&page=59)**

**[Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.](http://www.nap.edu/openbook.php?record_id=13165&page=59)**

* **[Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.](http://www.nap.edu/openbook.php?record_id=13165&page=59)**
  + 1. **Disciplinary Core Idea: [PS3.A: Definitions of Energy](http://www.nap.edu/openbook.php?record_id=13165&page=120)**
* **[Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.](http://www.nap.edu/openbook.php?record_id=13165&page=120)**

### **[PS3.B: Conservation of Energy and Energy Transfer](http://www.nap.edu/openbook.php?record_id=13165&page=124)**

* **[The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.](http://www.nap.edu/openbook.php?record_id=13165&page=124)**
  + 1. **Crosscutting Concept: [Scale, Proportion, and Quantity](http://www.nap.edu/openbook.php?record_id=13165&page=89)**
* **[Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes](http://www.nap.edu/openbook.php?record_id=13165&page=89)**
  + **Connections to Nature of Science Scientific Knowledge is Based on Empirical Evidence**
* **Science knowledge is based upon logical and conceptual connections between evidence and explanations**

1. Common Core State Standard Connections:

**ELA/Literacy:**

**ELA/Literacy**

* **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS3-1), (MS-PS3-5)
* **RST.6-8.3** - Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3)
* **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
* **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
* **WHST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS3-5)
* **WHST.6-8.7** - Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)

**Mathematics**

* **6.RP.A.1 - Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1), (MS-PS3-5)**
* **6.RP.A.2 - Understand the concept of a unit rate a/b associated with a ratio a:b with b â‰ 0, and use rate language in the context of a ratio relationship. (MS-PS3-1)**
* **6.SP.B.5 - Summarize numerical data sets in relation to their context. (MS-PS3-4)**
* **MP.2 - Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)**

**ELD**

Part I: Interacting in Meaningful Ways Corresponding CA CCSS for ELA/Literacy\*

A. Collaborative

1. Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics 2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia) 3. Offering and justifying opinions, negotiating with and persuading others in communicative exchanges

4. Adapting language choices to various contexts (based on task, purpose, audience, and text type)

B. Interpretive

5. Listening actively to spoken English in a range of social and academic contexts

6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language

7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area

8. Analyzing how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area

C. Productive

9. Expressing information and ideas in formal oral presentations on academic topics

10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology

11. Justifying own arguments and evaluating others’ arguments in writing

12. Selecting and applying varied and precise vocabulary and language structures to effectively convey ideas

**B. Content Research**

Students will need to understand the difference between heat and temperature, <https://docs.google.com/presentation/d/1gUa2j7u6yKGRTOqj0ofF0yx3NY8Br0DHMoj9jsbX-Xc/edit?usp=sharing> - slide presentation created based on the following information

Temperature and Heat - from ck12.org



#### **A candle flame or a bathtub full of hot** [**water**](https://www.ck12.org/c/biology/water)**: which has higher** [**heat**](https://www.ck12.org/c/chemistry/heat) **and which has the higher** [**temperature**](https://www.ck12.org/c/earth-science/temperature)**?**

The flame has higher [temperature](https://www.ck12.org/c/earth-science/temperature), but less [heat](https://www.ck12.org/c/chemistry/heat) because the hot region is very small. The bathtub has lower temperature, but more heat because it has many more vibrating atoms. Which has greater total energy? The bathtub.

### **Temperature**

**Temperature** is a measure of how fast the atoms in a material are vibrating. High temperature particles vibrate faster than low temperature particles. Rapidly vibrating atoms smash together, which generates heat. As a material cools down, the atoms vibrate more slowly and collide less frequently. As a result, they emit less heat. What is the difference between heat and temperature?

* Temperature measures how fast a material’s atoms are vibrating.
* Heat measures the material’s total energy.

### **Heat**

**Heat** energy is transferred between physical entities. Heat is taken in or released when an object changes state, or changes from a [gas](https://www.ck12.org/c/physical-science/gas) to a [liquid](https://www.ck12.org/c/physical-science/liquid), or a liquid to a [solid](https://www.ck12.org/c/physical-science/solid). This heat is called **latent heat**. When a substance changes state, latent heat is released or absorbed. A substance that is changing its state of matter does not change temperature. All of the energy that is released or absorbed goes toward changing the material’s state.

For example, imagine a pot of [boiling](https://www.ck12.org/c/chemistry/boiling) [water](https://www.ck12.org/c/biology/water) on a stove burner: that water is at 100°C (212°F). If you increase the temperature of the burner, more heat enters the [water](https://www.ck12.org/c/biology/water). The water remains at its [boiling](https://www.ck12.org/c/chemistry/boiling) temperature, but the additional energy goes into changing the water from [liquid](https://www.ck12.org/c/physical-science/liquid) to [gas](https://www.ck12.org/c/physical-science/gas). With more heat the water evaporates more rapidly. When water changes from a liquid to a gas it takes in heat. Since [evaporation](https://www.ck12.org/c/chemistry/evaporation) takes in heat, this is called evaporative cooling. Evaporative cooling is an inexpensive way to cool homes in hot, dry areas.

Substances also differ in their **specific heat**, the amount of energy needed to raise the temperature of one gram of the material by 1.0C° (1.8°F). Water has a very high specific heat, which means it takes a lot of energy to change the temperature of water. Let's compare a puddle and asphalt, for example. If you are walking barefoot on a sunny day, which would you rather walk across, the shallow puddle or an asphalt parking lot? Because of its high specific heat, the water stays cooler than the asphalt, even though it receives the same amount of solar radiation.

Some of the inquiry to be carried out by the students will use water as the substance whose heat capacity and temperature are being investigated. Water is a common substance, and its thermal properties strongly influence key natural phenomena such as wind convection or climate. On a few of the activities the investigations are extended to include air, as another substance that is highly responsive to changes in temperature. In this unit we are not as concerned with the relations between air temperature, pressure and volume, but the concept of temperature as an expression of the kinetic energy of the constituents of a substance is a good lead into a unit centered on atmospheric pressure and the Ideal Gas Law.

**C.** **Prerequisite Skills**

1. **Reading a thermometer**
2. **Using a scale to determine mass**
3. **Making a line graph**

**D. Activities:**

Engage: Phenomenon: Boiling water in a Paper Cup (Liquid) <https://docs.google.com/presentation/d/10EGk0k6U8afTuJKg5-2OoCec9uSmcXzKcH8hxQvuzLI/edit?usp=sharing> - there are 3 videos to choose from on the slide. Watch videos without sound. Compare scientific technique in each. Ask students to notice differences and make predictions based on how each is set up. Watch videos with explanation. (Sound on).

Heat and Temperature Lesson (Liquid) <https://docs.google.com/presentation/d/1gUa2j7u6yKGRTOqj0ofF0yx3NY8Br0DHMoj9jsbX-Xc/edit?usp=sharing> Additional lesson for Difference between Heat and Temperature for differentiation or clarification. Ed Puzzle #1 <https://edpuzzle.com/media/5af08effd80bb240f044fffb> #2 <https://edpuzzle.com/media/5aecea2d6b8cf740e35f4934> #3 <https://edpuzzle.com/media/5aeceab4e88a8340e9cdd108> <https://docs.google.com/document/d/10BuPCgAsxZhqZ67c-ownQtqXdTbDWFEs8nNRcZ4Gf3I/edit?usp=sharing>

Explore the difference between heat (the total kinetic energy of the molecules in a substance, which changes based on the mass or amount of the substance) and temperature (the average kinetic energy of the molecules in a substance, which is independent of the mass or amount of the substance). Temperature is measured with a thermometer, but heat can only be measured with a calorimeter. Lab experiment: Heat water up with an electric kettle (just warm it up, rather than letting it boil). Fill three or four containers, of different volumes, and have the students check that the temperature is the same between them (temperature does not vary as a function of the amount of water). Now have students place an ice cube in each of the containers, and measure the temperature every minute until the ice cube dissolves. Have the students compile the data, and analyze it by creating graphs of temperature versus time. Why did the ice cube melts faster in the big container than in the small container? Why does the temperature of the small container change more than that of the big container? Have the students prepare posters . Use argumentation based on evidence. Use notebooking. Note: Depending upon the size of your ice cubes, room temperature water may be a better choice. 7-10 minutes to full melt is optimum. Lab sheet <https://docs.google.com/document/d/1fa2FmH6frUTDhbA9tqGSebnReA9JOuQ90Co-EQsqzHw/edit?usp=sharing> Slides for Lesson <https://docs.google.com/presentation/d/1MPKpn0dryq4CMh5xsvfWOxbnSWHlTBPL30dFLxAZ0YA/edit?usp=sharing>

Convection <https://youtu.be/B8H06ZA2xmo>, <https://youtu.be/bN7E6FCuMbY> (Demo is Liquid, Transition students to properties of Gas)

Draw some heated and cooled air (gas). Can we think of a way to draw heated and cooled air? Let’s make some observations to give us some ideas.

Watch the video Balloon Microwave Magic <https://www.youtube.com/watch?v=vgPNh0FycCQ> Debrief. What was happening to the balloons as their temperature changed? Note: If you do this activity “live”, test it at home first, to see if a few drops of water need to be added to the inside of the balloon before inflating it (Note: Microwave ovens work at a frequency that is just right to add kinetic energy to water molecules)

Have students make scientific drawings of air inside a balloon at room temperature, in a heated balloon, and in a cooled down balloon. Use notebooking as a way to help students record the changes in their thinking about air. Optional activity: Go the PHET simulation on gas properties <https://phet.colorado.edu/en/simulation/legacy/gas-properties> This simulation allows students to investigate what happens to a volume of gas as heat is added to it, as the volume changes, and as the pressure changes. The simulation has all sorts of good teacher resources. I was having problems running this simulation, but I solved them by registering with the PHET website. <http://www.netlogoweb.org/launch#http://www.netlogoweb.org/assets/modelslib/Sample%20Models/Chemistry%20&%20Physics/GasLab/GasLab%20Adiabatic%20Piston.nlogo>

or <http://www.netlogoweb.org/launch#http://www.netlogoweb.org/assets/modelslib/Sample%20Models/Chemistry%20&%20Physics/GasLab/GasLab%20Free%20Gas.nlogo> Can be done whole class or have individual students on computers.

Test the insulating properties of different materials. Would require several cubes of ice. The students can bring different materials that they think might keep the ice from melting: paper, cloth, a plastic bag, a corn husk, aluminum, a large leaf. We used styrofoam, plastic and paper plates, along with an aluminum can. Have the students measure them (weigh them) at three minute intervals. Graph the results of time vs. mass of ice left. Use notebooking.

Test the insulating properties of different materials to keep a soda cold. Measure temperatures at beginning, 30 minutes and 60 minutes.

**E****. Summative Assessment**

**Students will design a “cooler” to keep a canned drink cool or an ice cube from melting, given a variety of materials.**

**F****. The Unit Plan**

Unit title: Energy Transfer

Overall approach: Planning and Conducting an investigation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lesson** | **Primary Instructional Strategy\*\*** | **Summary of Instructional Sequence of Lesson** | **Strategies for Students Who Typically Struggle with Science** ([English Learners](#1t3h5sf), Exceptional Students) | **Assessment Summary** (Briefly describe and label as Diagnostic, Formative, or Summative) |
| **1** | Engage  30-45 minutes | Phenomena:  Boiling Water in a paper cup  <https://docs.google.com/presentation/d/10EGk0k6U8afTuJKg5-2OoCec9uSmcXzKcH8hxQvuzLI/edit?usp=sharing> | EL students may draw their observations included as part of their diagram. | Students describe observations, make hypothesis and draw diagram of phenomena |
| **2** | Build Content  30-45 minutes | Heat and Temperature Slide Presentation  <https://docs.google.com/presentation/d/1gUa2j7u6yKGRTOqj0ofF0yx3NY8Br0DHMoj9jsbX-Xc/edit?usp=sharing>  <https://docs.google.com/document/d/10BuPCgAsxZhqZ67c-ownQtqXdTbDWFEs8nNRcZ4Gf3I/edit?usp=sharing>  <https://edpuzzle.com/media/5af08effd80bb240f044fffb> <https://edpuzzle.com/media/5aecea2d6b8cf740e35f4934> <https://edpuzzle.com/media/5aeceab4e88a8340e9cdd108> | Ed Puzzle videos may help EL, as they can repeat the video at crucial points. | Explain the difference between heat and temperature. |
| **3** | Exploration, data collection  1.5-2 hours | Using containers of three different sizes, measure changes in temperature using ice cubes of similar size.  Lab sheet <https://docs.google.com/document/d/1fa2FmH6frUTDhbA9tqGSebnReA9JOuQ90Co-EQsqzHw/edit?usp=sharing>  Slides for Lesson <https://docs.google.com/presentation/d/1MPKpn0dryq4CMh5xsvfWOxbnSWHlTBPL30dFLxAZ0YA/edit?usp=sharing> | Pre-labeled graphs  Add grid lines to graph!! | Students will weigh ice, measure temperatures of water in containers, chart and graph results. Formative |
| **4** | Demonstration  20-30 minutes | Convection <https://youtu.be/B8H06ZA2xmo>  <https://youtu.be/bN7E6FCuMbY> | EL students may draw only. | Students describe observations, explain results using academic vocabulary and draw diagram of phenomena using scientific drawings |
| **5** | Draw a Model  10-15 minutes | Draw models of air |  | Formative assessment: Draw scientific diagrams of air. |
| **6.** | Experimentation  20-30 minutes | Balloon Microwave Magic video  <https://www.youtube.com/watch?v=vgPNh0FycCQ> |  | Students will experiment to see how changes in temperature affect the movement and velocity (kinetic energy) of the molecules. |
| **7** | Draw a  Model  Drawings:  10-20 minutes  PHET:  1 hour | CFU: Draw air in three balloons: heated, cooled and room temperature. Have students revisit their original notebook drawings. s Optional Activities: <https://phet.colorado.edu/en/simulation/legacy/gas-properties>  <http://www.netlogoweb.org/launch#http://www.netlogoweb.org/assets/modelslib/Sample%20Models/Chemistry%20&%20Physics/GasLab/GasLab%20Adiabatic%20Piston.nlogo>  or <http://www.netlogoweb.org/launch#http://www.netlogoweb.org/assets/modelslib/Sample%20Models/Chemistry%20&%20Physics/GasLab/GasLab%20Free%20Gas.nlogo> Can be done whole class or have individual students on computers. |  | Formative assessment: Draw scientific diagrams of balloons at three temperatures |
| **8** | Exploration, data collection  1-1.5 hours | Test insulating properties of different materials, weigh ice cubes at varying times  Graph results  <https://docs.google.com/document/d/1fzsxQ-ed8bOt0HGI5koaVVZRGA_8Ytgx85svEtp8zh4/edit?usp=sharing>  <https://docs.google.com/presentation/d/1pYD2cTE2gFTMXvCFDS1brfEcICPcE3Vwf6xpOU8-BzY/edit?usp=sharing> | Pre-labeled graphs  Add grid lines to graph!! | Students will choose materials, test insulation, measure temperatures, and graph results |
| **9** | Exploration  1.5 hours (there will be down time while waiting for 30 minute increments) | Soda Cans  [https://docs.google.com/presentation/d/1GdfLkexgONqmnO3lVb5CuX6KAI6PTRkJptq9r4Va4A/edit?usp=sharing](https://docs.google.com/presentation/d/1GdfLkexgONqmnO3lVb5CuX6KAI6PTRFkJptq9r4Va4A/edit?usp=sharing)  <https://docs.google.com/document/d/1v6XLCIO3V04pPGeElTV0MsDrraLIKPC2ugD6uI6_ZXo/edit?usp=sharing>  <https://docs.google.com/presentation/d/1BZs7zKzlxfCWglYbvCknX9yAbFJckbPQ3iC17fkKL18/edit?usp=sharing> | Prelabled tables | Summative Assessment  Students will choose materials, test insulation, measure temperatures, and graph results |
| **10** | Engineering  1.5-2 hours | Design a cooler to keep a canned drink cold or an ice cube from melting  <https://docs.google.com/document/d/1EiOLck3mBX_4QkHaAfz5lm1fXh3pID8aNq_uChiohuQ/edit?usp=sharing>  <https://docs.google.com/presentation/d/1-M2pHG5n2xUua_DZkMfyldJz3qdfAX6VKw78uT5PD3Q/edit?usp=sharing> |  | Summative Assessment  Students will choose materials, test insulation, measure temperatures,mass, and make conclusions |

**G****. Lesson Plans, Support Materials**

Activity #2

CFA <https://docs.google.com/forms/d/e/1FAIpQLSf67Y1tFfDE2ny1xzFvGGs3kAyo5jydwbu-Wv7gFdQI5DjVlg/viewform?usp=pp_url> May not work correctly, but you should be able to copy using your Google forms.

Activity #3

Materials per group

Beakers of three different sizes

Three meat thermometers

Paper towels

Timer

Tray (optional)

Scales

Three ice cubes

Lab sheet

Activity #8

Materials per group

Scales

Styrofoam plate

Paper plate

Plastic plate

Soda can (full and sealed)

Ice Cubes

Lab Sheet

Activity #9

Materials per group

wool sock

paper towel

aluminum foil

plastic wrap

cotton sock

Soda can (full and sealed)

thermometer

(One option to lessen materials needed: Prepare trays with two of the above materials. Make sure every material is given to two groups. Average the two temperatures to “give” to the other groups before conclusions are made.)

Activity #10

Materials per group

plastic cup

small plastic cup

plastic wrap

paper plate

foam plate

foil

wax paper

2 cotton balls

scissors

Ice cube

Student Work:

<https://docs.google.com/document/d/1OoPJJ6NfsxkEzp7F5Pe-93QeITxiq5umFzRxFEtA12M/edit?usp=sharing>

<https://docs.google.com/document/d/1iNuKRfv_q5V_6CrwC8PnERKgONAPHGikiwmjBe4_kjQ/edit?usp=sharing>

Pictures of Lab in progress:

<https://drive.google.com/drive/folders/13mYaHI0wXtQBvWM-aoKlCsGE1Htr-zrR>