**Subject area/course**: Physical Science

**Grade level/band**: 9th

**Task source**: New Hampshire Task Bank; Authors: Ken Jacobs, Heather Wheeler, and Greg Connors

**Insulation Challenge Project**

**TEACHER'S GUIDE**

1. **Task overview**:

Students work in lab groups to construct and take data from a device designed to prevent heat loss from a small amount of water. Individual students then graph and analyze the data from this experiment and communicate conclusions about the effectiveness of their device. (See Student instructions for details explanations of each phase).

1. **Aligned standards:**
2. **Primary Common Core State Standards**

#### Key Ideas and Details:

[CCSS.ELA-LITERACY.RST.9-10.3](http://www.corestandards.org/ELA-Literacy/RST/9-10/3/)  
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

#### Integration of Knowledge and Ideas:

[CCSS.ELA-LITERACY.RST.9-10.7](http://www.corestandards.org/ELA-Literacy/RST/9-10/7/)  
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

[CCSS.ELA-LITERACY.RST.9-10.9](http://www.corestandards.org/ELA-Literacy/RST/9-10/9/)  
Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

1. **NGSS**

**HS-PS3-4.** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.*]

* **Planning and Carrying Out Investigations:** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

**PS3.B**. Conservation of Energy and Energy Transfer: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

**PS3.D.** Energy in Chemical Processes: Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

1. **Critical abilities**

**Modeling, Design and Problem Solving:** Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

**Experimentation and Evaluation:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

**Communication in Many Forms:** Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience.

1. **Other standards**

***New Hampshire Competencies***

**Nature of Science:** Demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research process and conclusions.

**Cause and Effect:** Demonstrate the ability to investigate, explain, and evaluate potential causal relationships by using evidence to support claims and predictions about the mechanisms that drive those relationships.

1. **Time/schedule requirements:**

This task is designed to be part of a 2-3 week unit, with the summative task taking about three instructional days.

1. **Materials/resources:**

Students should have:

* Student Instructions Page
* Scissors
* Rulers
* Thermometers
* Financial Planning Budget Template with Cost List
* $1000 (science bucks) to “buy” supplies. Supplies include:
* Wooden Popsicle Sticks
* Elmer’s white glue
* Small plastic cups (for glue)
* Cotton padding
* Aluminum foil
* Rubber Bands
* Wax Paper?
* Saran Wrap?
* Bubble Wrap?

1. **Prior knowledge:**

As part of this unit, teacher will need to plan lessons, reading materials, notes, and/or activities to explore the kinetic molecular theory in relation to heat transfer, in preparation for this task.

Some additional essential questions linked to this topic are:

* How does heat transfer from one molecule to another?
* How could knowledge of heat transfer be used to design better insulators?
* How does heat transfer explain the conservation of energy?
* How do we adapt to climate change?
* How does the conservation of energy impact engineering practices regarding heat transfer and insulators?
* What limits the efficiency of an insulator?
* How do you know an object has energy?
* How do insulators prevent heat transfer?
* How to keep cool in a warming environment?
* How could knowledge of heat transfer conserve energy?
* How could knowledge of the kinetic molecular theory in relation to heat transfer conserve energy between varying environments?

1. **Connection to curriculum:**

* Designed to be a Mid-Year Assessment
* Topics the task connects to:
  + Scientific Inquiry with design, data collection, graphing and analytical reasoning
  + Thermal Energy
  + Density
  + Electromagnetic Spectrum: Energy and Waves
  + Waves: Energy and Sound

1. **Teacher instructions:**

The steps in this process serve as benchmarks or points for formative assessment leading up to the task.

1. Generate testable questions or define problems
2. Plan and conduct investigations and communicates results
3. Analyze and interpret data
4. Constructing explanations and designing solutions
5. Effectively communicating conclusions
6. Cause and Effect
7. Follow-up Questions

* Students should be allowed to use any notes, formulas, or resources that they desire to complete the project. The only stipulation is that they must produce their own report.

***See student directions and Instructional Materials for more details.***

1. **Student support:**

*Possible accommodations:*

* Additional Time
* Oral reading of instructions
* Computer as needed for responses

1. **Extensions or variations:**
2. **Scoring:**

Student work can be scored using the Insulation Challenge Project rubric.