**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**

**STUDENT INSTRUCTIONS**

1. **Task context**:

*Essential question*: How can manipulation of heat transfer conserve energy between varying environments (systems)?

The insulation challenge is designed to give students the opportunity to work on a design engineering team. The concepts of kinetic molecular theory, temperature, heat, and heat transfer are applied through a hands-on engineering activity. Students will investigate the best method for preventing heat transfer (insulating to keep warm or cool).

1. **Final product**:

***Engineering Design Phase:***

* Teams will design an insulating device conforming to assigned constraints with the goal of preventing heat transfer from a 140 ml glass beaker of water at ~ 90ºC.
* Each student will submit a design plan including a scale diagram, a purchase order within budget, and a list of materials with known specific heat, mass, and dimensions prior to implementation.
* Additionally, each team member will submit a design hypothesis detailing the rationale behind the insulation design. (This will address mechanisms of prevented heat transfer, what makes for an insulating material, and how materials are proposed to be used to achieve successful insulation.)

CONSTRAINTS:

Cost of design materials shall not exceed a budget of $1000

Insulation devise must open and close to accommodate addition of beaker of water.

Insulation devise must offer accommodation for the insertion of a thermometer into the beaker of water.

***Manufacturing Phase:***

* Each team will build their insulation device *adhering to their design plan specifications*.

***Implementation Phase:***

* Each team will be given 140 ml of water at a temperature of ~ 90ºC in a glass beaker. Each team will place their beaker of water into their insulation device and record the initial temperature. Each team will record the temperature every 30 seconds for 20 minutes. At the end of 20 minutes, each team will record their final temperature.

***Analysis Phase:*** *Each student will submit an Insulation Design/ Heat Transfer Analysis consisting of the following:*

* Graph of temperature data, appropriately laid out (independent/dependent variables on correct axes) and labeled
* Calculation of energy transfer due to heat loss in joules (must show work with all units)
* Detailed explanation in paragraph form discussing the results of the insulation challenge:
  + Include a description of the Kinetic Molecular Theory of Matter and the three means of heat transfer.
  + Include discussion of quality of insulation, heat transfer, and possible modifications to design.
  + Include an explanation of the energy movement that took place during the insulation challenge in terms of molecular activity.

***Conclusion Phase:*** *Each student will submit an Insulation Design/ Heat Transfer Conclusion consisting of the following:*

* Include a discussion of the way in which the manipulation of heat transfer could be used to conserve energy between systems.
* Include discussion of opportunities for further investigation prompted by this insulation challenge.

**ADDITIONAL INFORMATION**

1. **Knowledge and skills you will need to demonstrate on this task:**

Students are able to:

* Predict heat transfer based on understanding that heat transfer is a function of mass, specific heat, and temperature difference.
* Explain the three types of heat transfer: convection, conduction, and radiation.
* Calculate heat transfer as energy lost/gained between systems*.*

Overall, more generally, students will be able to:

* Define Problems
* Plan and conduct investigations
* Analyze and Interpret Data
* Make a claim
* Use data/evidence to support a claim
* Communicate research results and conclusions
* Explain the cause and effect relationship between the data connected and the real-world scenario

1. **Materials needed:**

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?
* Seran Wrap?
* Bubble Wrap?

1. **Time requirements:**

This task is designed to be part of a 2-3 week unit, with the summative task taking about three instructional days. Your teacher will provide you with more details about each step in the task.

1. **Scoring:**

Your work will be scored using the Insulation Challenge Project rubric. You should make sure you are familiar with the language that describes the expectations for proficient performance.