Science Assessment System
Through Course Task

Icicles on My House

Grade Level:
7

Phenomena:
Formation of Icicles

Science & Engineering Practices:
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions

Crosscutting Concepts:
Energy and Matter
Cause and Effect

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations. Success criteria include:
    - What is this task designed to get evidence of?
    - What is the task asking the students to do?
    - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
    - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - <u>Crosscutting Concepts</u>
- **Student Task:** The materials to be used by students to complete the TCT.

Icicles on My House Task Annotation

After **analyzing and interpreting data** of *the temperature differences of two homes*, **identify three factors and explain why these factors could** result in **larger icicle formation** using energy transfer within the system to support your explanations.

Phenomenon within the task

When atmospheric conditions are right, icicles form on the edges of the roofs of structures. After a snowfall, some of the snow can melt, flow toward the edge of a roof, and then refreeze before dripping to the ground, which can result in icicle formation. Depending on the energy transferred to the roof by the sun, or through the roof from the inside of the house, different sized icicles could form for structures collecting the same amount of snowfall because different melting would occur between the two structures' roofs. Snow generally melts on roofs due to three different heat sources: 1) heat from within the house is transferred through the roof causing the snow on the roof to melt, 2) solar radiation warms the roof and melts the snow or 3) the outside air temperature is above freezing and the snow melts. In this task, two houses in the same geographical area experience the same snowfall on their roofs, but the icicle formation is different. Students are provided some data about the houses and asked to identify and explain known factors about the two houses that could provide evidence for why the icicles are much bigger on one house than the other.

Thermal energy will always move from high energy areas (hotter) to lower energy areas (colder). A common misconception to look for is that students believe that areas cool because of "coldness." Cold is not a thing, it is simply the absence of heat.

How the phenomenon relates to DCI

PS3.A: Definitions of Energy

- 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.

PS3.B: Conservation of Energy & Energy Transfer

- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

What information/data will students use within this task?
Data table of information about the two houses, including average heating bill costs, thermostat settings, roof temperature, floor and ceiling level temperatures and thickness of snow on the roof is provided.

The assumption is made that students have the following prior knowledge:

- Thermal energy transfer is heat.
- Transfer of energy can be tracked as energy flows through a designed or natural system.
- 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.
- Understanding that energy is spontaneously transferred out of hotter regions or objects and into colder ones.

Ideas for setting up the task with students
This task is about transfer of thermal energy. Therefore, depending on your class, teacher teams may need to remind students:

- Different materials conduct thermal energy at different rates.
- Thermal energy transfers from areas of high to areas of low.
- Transfer of thermal energy can allow for a phase change. (Here it is snow melt; it takes energy for this phase change even though the temperature doesn't change.)

In addition, success with the task depends on students having an understanding of how icicles form. Even though this information is provided in the task, and the background knowledge to make sense of the text is appropriate for middle school students, it is recommended that the teacher orchestrate a class discussion about this phenomenon to ensure that all students have this understanding before proceeding with the task. Teachers may even want to look for videos about icicle formation to support this understanding.

Intent of the Task for Assessment
In this task students are provided information about two homes, both of which have different sized icicles hanging from their roofs, although outside conditions are the same. Students are asked to identify which parts of the information could provide evidence for **why** the icicles form bigger on one house than the other, and explain **how** the information can be used as evidence. Thus, students will have to analyze the data provided for both houses, use their background knowledge about thermal energy transfer, as well as

information about how icicles form. All of this is provided in the task. It is suggested that the teacher orchestrate a class discussion about icicle formation after students have read that text to ensure this understanding is not a barrier to attaining the desired assessment outcome.

Students are first asked some scaffolding questions about the data table to encourage engagement with the data; these are the first three questions in the task. Student response to these questions will also provide evidence of student understanding as the student engages with the most challenging aspect of the task: identifying information from the data set that provides evidence for why that information supports the formation of larger icicles. Students will provide evidence of their ability to construct a scientific explanation for how the factor in the table provides evidence for the formation of larger icicles. Although causality is present in reasoning through this task (what ***causes*** the larger icicle to form?), the crosscutting concept that students should also provide evidence of "energy and matter," and specifically "within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter."

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Analyze and Interpreting data

- Analyze and interpret data to provide evidence for a phenomena.

Construct Explanations

- Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Energy and Matter

- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Success Criteria

Student identifies three relevant factors from the table and explains how this factor will affect icicle formation based on causality and energy transfer.

Possible Student Responses

- The roof at Jason's house is warmer than Jessica's house (36 vs 33). This means that more water will melt on Jason's house (more thermal energy to melt snow) and can turn into an icicle or make a bigger icicle.
- The snow is thinner on Jason's house than Jessica's house (2.8 vs. 4.6 inches) even though both houses originally got 5 inches of snow. This means more snow melted on Jason's house and could make a bigger icicle.
- Jessica's house has more attic insulation than Jason's house. This will reduce thermal energy transfer through the roof on Jessica's house and less snow will melt, resulting in smaller icicles than Jason's house.

Other information teacher teams might find useful when preparing to use this task in the TCT process

An understanding of thermal energy is necessary for success with this task. It is suggested to use the task after students have been had experiences with heat: conduction, convection and radiation.

Extensions and/or other uses after the task is implemented

Teachers could provide more information about the shelters. For example, after teaching about absorption of light energy, they could specify the colors of each of the shelters. Teachers could also say that there is a "no bonfire" rule in the location of the shelters, and ask students to provide design solutions for how to provide a thermal energy source for the shelters. This could include using multiple people to provide body heat, or painting the shelters black to absorb solar energy, which then converts to thermal energy.

Possible Extension Task:

Create a model to show how the energy transfer is different between these two homes. Be sure to label the diagram.

Through Course Task – Icicles on My House

Jason and Jessica are two middle school students that live in Central Kentucky. They noticed that after every snowfall Jason's house develops large, dangerous icicles while Jessica's house produces much smaller icicles. Both homes are single story houses that are 1500 ft^2 in area. In order to make sense of the phenomenon, the two friends researched icicle formation.

Jason's House

Jessica's House

ICICLE RESEARCH: Icicles only form when the air temperature is below freezing (32^{o}F). Typically, a heat source warms snow on a roof (such as sunlight or heat from inside of the house) causing some of the snow to melt and flow towards the edge of the roof. The melt water begins to drip from the roof edge but re-freezes before falling to the ground. The process continues as more melted water gradually refreezes creating the common shape of an icicle. Icicles may form over several hours or even days if the conditions are right.

Jason and Jessica now understand how icicles form, but they still wondered why the two houses produced different sized icicles. They decided to observe their homes for a 24-hour period after a six inch snowfall blanketed their neighborhood. They each noticed that both home's thermostats were set to 70 degrees, and each house was heated using identical electrical central heating units.

After careful observations, the two friends constructed Table 1A.

Table 1A

Observations:	**Jason's House**	**Jessica's House**
External temperature of roof surface	36°F	33°F
Average snow thickness on roof (5 inches originally)	2.8 inches	4.6 inches
Temperature at thermostat height (5 ft above floor)	72°F	72°F
Temperature at floor level	58°F	64°F
Temperature at ceiling (8 ft above floor)	70°F	75°F
Attic insulation (above ceiling) thickness and type	3 inch thick fiberglass	8 inch thick rolled fiberglass
Color of Inside Walls of the House	Orange	Orange
Average energy bill cost/month	$335	$245
Number of times the heat pump kicked on in one hour	4 times - ran a total of 40 minutes	2 times - ran a total of 20 minutes

Task - After thinking about how icicles form based on the text of *Icicle research,* analyze the data from *Table 1A* and consider how the information might provide evidence for why icicles form much bigger on Jessica's house than Jason's house. Think about how the information in the table could give evidence of how thermal energy is being transferred through each house and what that could mean for icicle formation.

Consider the following questions to stimulate your thinking about the information in table:

1. Which factors are the same between the two houses? Which factors are different?

Same	**Different**

2. What could cause Jessica's roof to be cooler than Jason's? (Remember that they are in the same neighborhood.) List as many factors as you can.

____

____

____

____

3. What could cause the snow to be thicker on Jessica's roof than Jason's roof?

____

____

____

____

4. Explain how data about the houses supports larger icicle formation.

Refer back to the pictures of Jason's and Jessica's houses. Why are the icicles so much bigger on Jason's house? Identify three pieces of information from the table that could be used as evidence to explain why Jason has much bigger icicles on his house. Provide reasoning for why the information supports the formation of larger icicles in terms of energy transfer.