Achieve

# SCIENCE TASK ANNOTATION

ANNOTATION KEY

**EQUITY**
Supporting a wide range of diverse students.

**SCENARIOS**
Information provided to elicit performances.

**SEPs**
Opportunities to demonstrate science and engineering practices.

**DCIs**
Opportunities to demonstrate understanding of disciplinary core ideas.

**CCCs**
Opportunities to demonstrate understanding of crosscutting concepts.

**SENSE-MAKING**
Opportunities for reasoning about phenomena and problems.

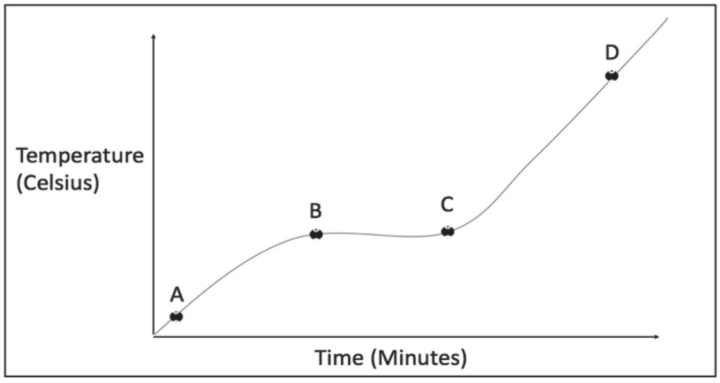
**ASSESSMENT PURPOSE**
Highlights how the task features connect to intended assessment use.

## UNIT 1: EVAPORATION- "EVAPORATIVE COOLING"

Scenario 1: To investigate how the temperature of ice changes on a hot summer day, Kellie put three thermometers in ice cube tray wells, filled the wells with water, and put the tray in the refrigerator overnight. In the morning, she took the tray outside and recorded the temperature of three ice cubes as well as her observations of what happened to each cube. The average temperature change of the three cubes is reported on the graph below:

**This is the driving question of the task. While it is accessible to students, the task does not make clear why this is an investigation that would be relevant, puzzling, or need to be addressed. The scenario would be improved if it started with a surprising, specific observation and it was clear that the answer wasn't immediately obvious. As presented, there is nothing particularly intriguing or problematized about this scenario, limiting the possible sense-making that might be elicited.**

SCENARIOS




Kellie wrote her observations in the table below:

| Time Point | Observation |
|---|---|
| A - B | Mostly solid ice |
| B - C | Mixture of ice and water |
| C - D | Mostly liquid water |

Kellie was curious why the water was sometimes increasing in temperature, while at other times it did not change its temperature but was changing from solid to liquid.

**This is a nice attempt to make clear to students the uncertainty of the phenomenon—however, this uncertainty is something that is unclear to the fictional Kellie, not something that should be uncertain to students taking the assessment if they have had sufficient instruction around the DCI targeted. Because students likely already know the answer to Kellie's question, it is likely that the task items associated with this scenario are going to ask students to show their understanding of the DCI, not use the DCI to make sense of a phenomenon.**

SCENARIOS DCIs SENSE-MAKING

# UNIT 1: EVAPORATION- "EVAPORATIVE COOLING" (CONTINUED)

**Item 1.** What caused the ice to increase in temperature between points A and B? Use ideas about energy to describe what occurs at the molecular-level and how that relates to the temperature of the ice.

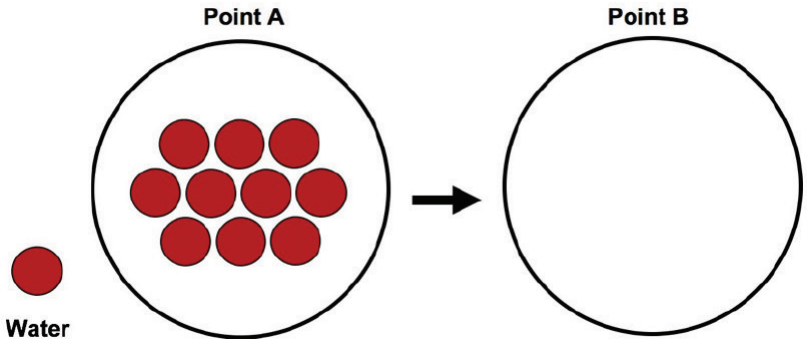
To successfully respond to this question, students need to understand that as the ice sits in the sun, particles making up the ice are moving increasingly rapidly, which results macroscopically in an increase in temperature. This most closely connects to parts of the MS DCIs PS1.A and PS3.A—these don't reach the sophistication expected at the high school level because students don't need to use their understanding of electrical forces within and between atoms to address this question. This is an example of students restating their understanding of the DCI, rather than using the DCI to support sense-making.

DCIs SENSE-MAKING

Item 2. Below is a molecular-level drawing of water molecules at point A. Using your explanation from the previous question, construct a molecular-level drawing of these.

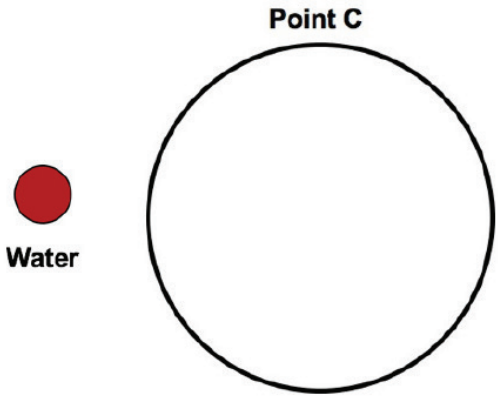
To successfully respond to this item, students must be able to diagram their response in **Q1.** This is an example of students engaging in simple mechanics of modeling. However, it does not reach the level of modeling as an SEP because students are not making sense of anything by drawing this diagram—they are representing their understanding of the DCI. This offers students multiple ways to make their thinking visible by providing a diagram option in addition to the written option in Q1.

SEPs SENSE-MAKING EQUITY



# UNIT 1: EVAPORATION- "EVAPORATIVE COOLING" (CONTINUED)

Item 3. Based on the drawing of water molecules from the previous question, construct a molecular-level drawing of these molecules at point C.




**To successfully respond to this item, students must 1) know that melting—the process of going from solid to liquid—involves molecules moving rapidly and farther apart by overcoming attractive interactions at the molecular level and 2) be able to draw this.**

**While this item still focuses on representation rather than sense-making, this question more closely addresses the HS-level DCI understanding than previous items because students have to know that when the sample is continuing to be heated but the temperature of the ice isn't changing, energy is used to overcome the attractive electrical interactions among water molecules. This is an example of a diagram of a DCI—a molecular diagram of a liquid—not a model explaining and phenomenon.**

DCIs SEPs

# UNIT 1: EVAPORATION- "EVAPORATIVE COOLING" (CONTINUED)

Item 4. Using the drawing you constructed in the previous question, explain why the temperature did not increase between points B and C.

Focus on forces and energy in your explanation.

Students are asked to show that they understand the molecular underpinnings of phase changes, by applying that understanding to the provided observation. The task cites "use the drawing," emphasizing that while this requires some of the skills and understanding associated with modeling, this is more an example of applying a DCI than engaging in the SEPs in service of sense-making.

SEPs SENSE-MAKING

To successfully respond to this prompt, students must:
1) know that phase changes involve energy being used to break bonds holding molecules within a close structure, rather than to move more rapidly,
2) know that temperature increases are associated with movement, so when matter undergoes phase changes, energy released does not manifest as an increase in temperature, and
3) connect this to electrical forces between atoms.
This most closely relates to part of HS.PS1.A ("the interactions of matter at the bulk scale are determined by electrical forces within and between atoms") and HS.PS.2B ("attraction and repulsion between electric charges at the atomic scale explain...transformations of matter...").

DCIs SENSE-MAKING

This is a nice scaffold, helping to cue students toward which aspects of the DCI is expected in student responses.

EQUITY

# UNIT 1: EVAPORATION- "EVAPORATIVE COOLING" (CONTINUED)

**Scenario 2:** Kellie decided to try the experiment again, only this time using another substance to see if the new substance behaves the same as water. To do so, she poured rubbing alcohol into three cubes in the ice tray next to three cubes with water, putting a thermometer to each cube and placing the tray in a freezer.

After several hours, she took out the tray and noticed that, although both substances were at the same temperature (about -6 degrees Celsius), the rubbing alcohol did not freeze and remained liquid, while the water cubes were mostly frozen ice.

Compared with scenario 1, this is a stronger scenario as it presents a more puzzling and specific instance: 2 liquid substances were cooled to the same temperature, but one is a solid and the other isn't. While it still is not clear why this is problematic or needs to be addressed, it is more intriguing than the previous scenario. It should be noted, however, that this can be easily explained using MS DCIs—if students have had experience with those DCIs, this might not be puzzling or intriguing, and it might be difficult for this scenario to engage students in sense-making.

SCENARIOS SENSE-MAKING

Kellie was curious why, even though the two substances were at the same temperature, the water was a solid while the rubbing alcohol was still a liquid.

This is a nice example of making the uncertainty students need to figure out very clear to students.

SCENARIOS

She sought a molecular level explanation for the difference in properties between rubbing alcohol and water. To help her with this, let's construct some molecular-level drawings.

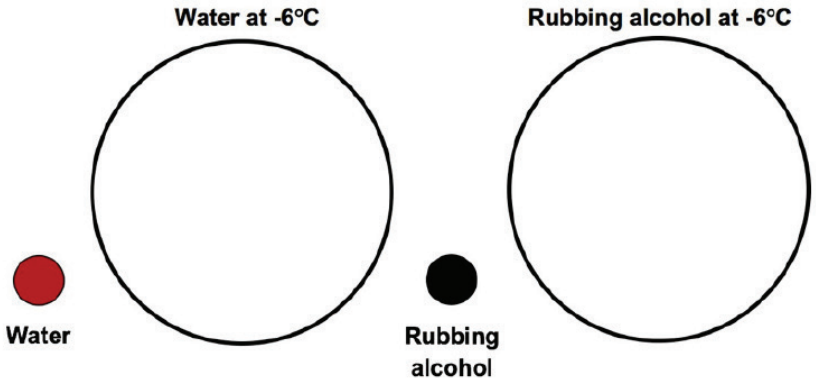
# UNIT 1: EVAPORATION- "EVAPORATIVE COOLING" (CONTINUED)

Item 5. In the circles below, draw a molecular level representation of the water and rubbing alcohol molecules at -6 degrees Celsius.

Successfully responding to this question requires that students know how molecules behave in liquids and solids. This most closely connects to parts of the DCIs targeted in previous parts of the task.

This asks for a representation, rather than some form of sense-making; therefore, while it elicits mechanics associated with the early (K–5) expectations of SEP developing and using models, this is not an example of students engaging in the SEP at the HS level.

DCIs SEPs




**Item 6.** Using the drawings above, explain when Kellie took out the tray from the freezer, the water was still mostly solid but the rubbing alcohol was liquid. Focus your explanation on the relative strength of the electric forces between molecules.

Successfully responding to this question requires that students know how the relative strength of forces between molecules changes with temperature—this is a representation of student understanding of the **HS** DCI. In this item and the item above, students are using very simple application of the DCI, rather than meaningful sense-making of a phenomenon or problem—but this moves beyond rote understanding and toward **meaningful** sense-making.

DCIs SENSE-MAKING