Science Assessment System
Through Course Task

Salt Bath Design

Grade Levels:
9, 10, 11, 12

Phenomena:
Solubility of Ionic Compounds

Science & Engineering Practices:
Asking Questions and Defining Problems
Analyzing and Interpreting Datat
Engaging in Argument from Evidence

Crosscutting Concepts:
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*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Salt Bath Design Task Annotation

After analyzing the criteria required by a chemist for *maintaining the solubility of a salt water bath over a specific range of temperatures,* **develop an argument** for *which salt(s) would be appropriate for use and which salt(s) would not, based on the solubility* trends (patterns) for the various salts available.

Overall intent

The intent of this TCT is assessment of the students' ability to analyze solubility trends/patterns in a quantitative model for many substances in order to make a valid and reliable claim supported by functional trends from the model.

Phenomenon within the task

The solubility of ionic compounds is dependent on the temperature of the solution.

Ideas for setting up the task with students

Students should have experience defining design criteria based on information about a problem to be solved. As time goes on with more authentic implementation of Kentucky's science standards, this will be less of an issue; current students may struggle with this if they have not had exposure to the design process. Students should also have experience with writing claims, providing evidence supported with sound reasoning. Facilitation of the task could include review of key terms in the task or unfamiliar words. Although perhaps not explicitly critical, but important to the authenticity of the task in the minds of students, the students should understand factors that affect solubility, specifically, temperature. In addition, students could explore the purpose of salt baths in laboratory settings. Students may need support in interpreting graphs with many variables. Perhaps one of the larger challenges for students is the presentation of many variables on the same graph. Teachers may want to support students by helping them identify strategies to facilitate the interpretation of a graph with many variables. Students may also struggle interpreting the information in the graph as "solubility trends," and how these trends affect meeting the criteria for the salt bath.

Intent of the Task for Assessment

The specific intent of the task is to get evidence that students can interpret a graph/model that shows the functional relationship of the solubility trends of many substances with temperature, and use that interpretation as evidence to support defined criteria that can addressed/evaluated against this functional relationship. So there are two important components: 1) interpreting the graph/model in a scientifically relevant way for the context presented, and 2) making claims and supporting them with reasoned evidence support by component 1. But first, it is important that students appropriately define the criteria for the salt bath (question A in the task). Teachers may want to review the student's criteria before students proceed with questions B and C in the task. A teacher would want to note which students struggled with defining appropriate criteria, and why. Is it because the student doesn't understand what it means to define criteria, doesn't understand the context for the task, or something else? Much information about students can be gleaned from question #1, but it is not the primary assessment intent of the task. Students will present their understanding of the assessment intent by making a claim and supporting it with reasoned evidence based on an appropriate interpretation of the functional relationship of the solubility trends of many substances with temperature. They will do this for salt(s) that will and will not meet the defined criteria. Questions B and C are structured to require the identification of two salts in order to provide additional evidence of a student's depth in using the solubility graph/model and effectively communicate the use of the model in solving the salt bath problem.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

- "Analyze data using tools, technologies, and/or models (e.g., computation, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution." SEP 4
- "Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables." SEP 6
- "Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system." CCC 1
- **While this does not exactly match the context of this task, it can meet a similar intent, rephrased as: Patterns indicating the performance characteristics of a component(s) of a system can be analyzed and interpreted for design purposes.**

Success Criteria

1. Students accurately define the required criteria for the salt bath based on the provided text in the task. (This should be scaffolded as necessary so that the evidence of the remaining success criteria components are not clouded by misunderstanding of the problem asked.)
2. Student makes a valid claim for a salt that meets the defined criteria, and supports this claim with evidence and reasoning based on the solubility trends (patterns) in the graph/model presented. Student makes a valid claim for a second salt that meets the defined criteria, and supports this claim with evidence and reasoning based on the solubility trends (patterns) in the graph/model presented, or provides additional evidence for why the first salt is the only one that will meet the criteria.

3. Student makes a valid claim for a salt that will not meet the defined criteria, and supports this claim with evidence and reasoning based on the solubility trends (patterns) in the graph/model presented.
4. Student makes a valid claim for a second salt that does not meet the defined criteria, but for different reasons than the first salt, and supports this claim with evidence and reasoning based on the solubility trends (patterns) in the graph/model presented.

Possible Student Responses

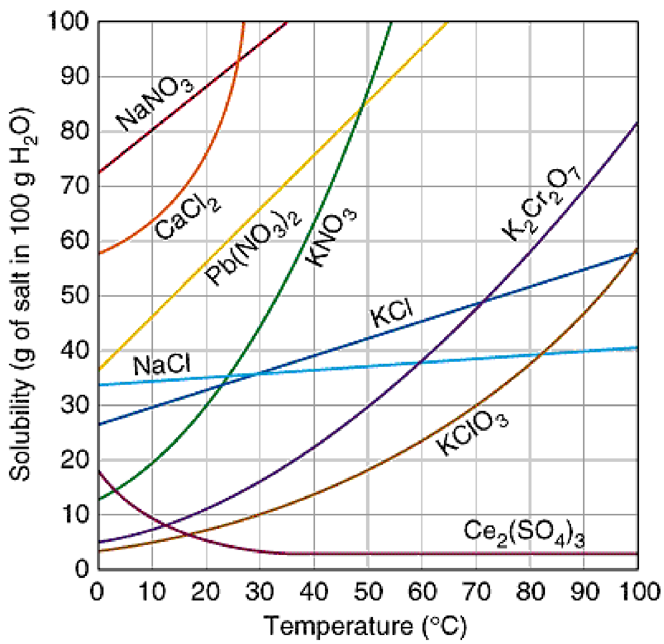
- Success Criteria 1: The salt must remain soluble between the expected temperature range of 10-70°C.
- Success Criteria 2: NaCl – This salt starts and ends at a midrange of all solubilities and remains soluble over all the temperature ranges. The solubility of this compound does not fluctuate wildly with temperature, NaCl changes from 34g/100gH_2O to 41g/100gH_2O (+7g) over a 100ºC temperature change.
  - (KCl would also meet the criteria but perhaps not as well, depending on factors not identified by the information provided.)
- Success Criteria 3: Any salt OTHER THAN sodium chloride, NaCl, or potassium chloride, KCl, does not have appropriate solubility characteristics. (This is only a claim.)
- Success Criteria 4: $Ce_2(SO_4)_3$ - The solubility of this compound decreases from 18g to almost 0g over 100ºC temperature change. This is not a moderate solubility and the solubility of this compound decreases as temperature increases.
  or
  Any compound other than NaCl or KCl. All the other compounds solubility will vary drastically over the 100ºC temperature range and thus would not be suitable to allow the chemist to complete their experiment. (Lacks specifics.)

Through Course Task – Salt Bath Design

Malia Smith is a scientist in a chemistry lab. She is conducting an experiment that requires electrodes to be placed in a salt water bath (a container of water containing a dissolved salt). In order for Malia to accurately complete her test, the salt in the bath should remain soluble throughout the experiment despite possible fluctuations in temperature. She expects the temperature to vary between 10°C and 70°C for all conditions tested. Malia heads to her chemical cabinet in which she has several soluble ionic compounds. The chemicals that she has are:

Sodium nitrate, $NaNO_3$	Sodium Chloride, NaCl	Potassium nitrate, KNO_3
Potassium chlorate, $KClO_3$	Potassium chloride, KCl	Lead (II) nitrate, $Pb(NO_3)_2$

To choose which salt she is going to use for her salt bath, Malia pulls out the diagram below from her chemistry textbook.



A. Define the criteria required for a salt water bath that will Malia's needs for the conditions proposed.

B. Which of the salts would best meet the criteria required for Malia's salt bath? Justify your proposal based on the trends (patterns) presented in the solubility graph/model.

If you feel two of the salts would reasonably meet the requirements, identify two salts and justify your proposal. If you do not feel that a second salt would meet the criteria, further explain why the first salt you chose is the only salt that will work.

C. Which of the salts would clearly <u>not meet</u> the criteria required for Malia's salt bath? Justify your proposal based on the trends (patterns) presented in the solubility graph/model.

Identify a different salt that would not meet the criteria, but for different reasons than the first salt. Justify this proposal based on the trends (patterns) presented in the solubility graph/model.