Science Assessment System
Through Course Task

Mentos® and Soda

Grade Level:
9, 10, 11, 12

Phenomena:
Release of dissolved CO_2 due to Nucleation Sites

Science & Engineering Practices:
Asking Questions and Defining Problems
Planning Carrying Out Investigation

Crosscutting Concepts:
Patterns
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.

Mentos® and Soda Task Annotation

After **analyzing experimental conditions and the resulting data from two similar explorations of the** *reaction of Mentos® candy and soda*, **develop investigable questions based** on patterns *that you observe in the data*.

After **asking questions** about varied experimental conditions *that potentially affect the reaction of Mentos® candies and soda (amount of soda expelled)*, **plan an investigation that when conducted** would help establish a causal relationship between an *experimental variable and the amount of soda expelled*.

Phenomenon within the task

Carbon dioxide is dissolved in carbonated beverages (soda) so that an unopened soda is essentially bubble free due to the pressurized condition of the sealed can/bottle. When the soda is opened to the atmosphere, some of the dissolved carbon dioxide turns to gas and rises to the top of the container and into the atmosphere. Adding Mentos® candy to a soda greatly speeds up this release of carbon dioxide gas by providing nucleation sites for the carbon dioxide bubbles to forms (the candies are very porous). The reaction between the candy and the carbon dioxide is not a chemical reaction, but is a physical reaction – dissolved CO_2 is attracted to the nucleation sites and turns to gas, which rises due to differences in density. It is the rapid release of CO_2 as a gas that causes the geysers observed when the candies are dropped into soda.

Many students and teachers across the state have experienced the phenomenon of placing Mentos® Candies into soda because it is exciting. Even though the Mentos® and Coke phenomenon is not a chemical reaction, teachers can use the process to connect molecular energy to reaction rate.

How the phenomenon relates to DCI

PS1. B - Molecular motion (energy) of the components in the system are affected by variables of reaction rates.

Connection: The Kinetic Theory of Matter states that matter is composed of a large number of small particles—individual atoms or molecules—that are in constant motion. The rate at which chemical reactions occur is affected by the energy of particle motion and the number of collisions between the particles.

Note: Even though it is NOT a chemical reaction, we can examine the Mentos and soda phenomenon to observe how molecular motion/energy plays a role in determining how substances behave.

What information/data will students use within this task?

Students will watch videos on the Mentos® and soda phenomenon to familiarize themselves with the phenomenon and begin to think about any factors that might affect the magnitude of the reaction. Students are also presented with two similar but different experimental setups for Mentos® and soda that produce different results (different amounts of soda are expelled for the two experimental setups). The factors that vary in the experimental setup are: sugar vs. artificial sweetener in the soda, temperature of the surroundings, temperature of the sodas, pressure of the surroundings and number of Mentos candies. Students will use their understanding of the particle nature of matter, influence of heat on the motions of particles, the effect of differing pressure, etc., as they generate questions that would explore the differences in the outcomes of the two experimental setups.

Students must understand characteristics of a testable scientific question based on the relevant variables and be able to explain the reasoning for the question choice. Students must also have experience with experimental design: independent and dependent variables, constants and controls, trials, etc.

Ideas for setting up the task with students

By watching the videos and examining the given data, all students enter the task with the same prior experience and understanding of the phenomenon. Also, students should have had previous classroom experience in asking questions based on observation, analyzing data with ability to evaluate a testable scientific questions, asking questions about patterns based on observations and designing an experiment related to a question. Students should also have a firm understanding of experimental design and variables.

Intent of the Task for Assessment

This task was designed to engage students to think about factors that might affect the results of a physical reaction for a fun phenomenon that they have observed, either personally or through video. The conditions for the two experiments are different and offer the opportunity for a teacher to get insight into a student's general understanding of scientific factors that might affect the physical reaction of the Mentos® and soda based on the questions asked and the justification for why the answer to the question would be useful. The task then provides evidence of the student's competency with experimental design. (The differences in the experimental conditions between the two set-ups likely affect the results of the reaction in different ways, or one factor may significantly outweigh other factors. For example, higher temperature of the soda likely speeds up the reaction, but the presence of the artificial sweetener may have a larger impact than temperature. It is not important for the purpose of this task to identify which factor has the largest affect, but to determine if the student can identify a factor and explain why that factor may affect the reaction.)

Evidence includes questions and an investigable question testing appropriate variables. Variables will differ per student. An extension asking for appropriate measurement tools for obtaining meaningful data is included.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Asking Questions and Defining Problems

- Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.
- Determine relationships, including quantitative relationships, between independent and dependent variables.
- Evaluate a question to determine if it is testable and relevant.

Analyzing and Interpreting Data

- Consider limitations of data analysis when analyzing and interpreting data.

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis of 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 and refine the design accordingly.
- Select appropriate tools to collect, record, analyze and evaluate data.

Patterns

- Empirical evidence is need to identify patterns.

Cause and Effect

- Empirical evidence is required to make claims a*bout specific causes and effects.*

Success Criteria

- Student develops valid questions based on identifiable variables between the two experimental setups that may affect the experimental outcome, using patterns in the data and differences in the experimental setups.
- Student provides reasoning for why their question will provide useful information about a factor that affects the reaction between Mentos and soda.

- Student creates an experimental plan to answer their chosen question, which must have clear variables that can be manipulated one at a time with multiple trials, and controls specified.

Possible Student Responses

- “What would happen to the foaming amount or height if more/less mentos were used?”
- “What would the effect be if a different size/shape of a container were used, i.e., smaller, larger, more height, etc.? ”
- “Would the type of liquid (regular coke, diet mt. dew, water) used affect the foam system outcome?”
- *Or any other scientifically valid question.

Students will then choose one of those questions that they evaluate to determine if it is testable. They will indicate how the chosen question is scientifically valid and testable. Changing one variable. Identifying the independent and dependent variable.

Students will look at patterns within the different videos and analyze the data given to ask investigable questions. Variables should be formed to determine relationships between the independent and dependent variables.

The independent and dependent variables would be identified. Constants and controls would be identified. \The plan of design investigation would be described. Methods of measurement would be defined.

Answers vary but should include one variable changed with independent and dependent variables identified. How this will be performed and measured.

Stopwatches to see how long the fountain lasts, meter sticks and/or cameras to measure how high the foam extends, graduated cylinder of the amount of coke left in the bottle after the reaction, various size/shape (calculate volume) containers to record any effect of foaming, thermometer to record if any temperature difference within the system. These tools will reduce error as opposed to just visualizing.

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

Students need experiences with forming questions from observations and patterns. Students need to be familiar with the scientific process for investigations which include testing appropriate variables.

Extensions and/or other uses after the task is implemented

Extensions could include actually conducting the designed investigation within the system to collect data and make conclusion. If teachers choose to have students carry out their investigation as an extension of this process, another suggestion could be to discuss with students how they would take valid measurements in their investigation (meter stick measurement, photo evidence, volume remaining in the bottle, etc.).

Through Course Task – Mentos® and Soda

Name:___________________________________

Watch the following links about the interaction between Mentos® candies and soda to familiarize yourself with any factors that might affect this kind of interaction.

Video 1

Video 2

Video 3

Experiment #1

Observations were made of 5 trials of the physical process of Mentos® candies causing the release of CO_2 from soda. The information below describes the conditions under which the observations were made and the data table contains the beginning and ending volume of the liquid before and after the soda geyser was observed.

- Diet soda (artificial sweetener)
- 7 Mentos® Candies
- Elevation: 1000 ft above sea level
- External air temperature: 70 degrees Fahrenheit
- Internal liquid temperature: 52 degrees Fahrenheit

	Beginning Volume	Ending Volume
Trial 1	2 liters	.68 liters
Trial 2	2 liters	.74 liters
Trial 3	2 liters	.78 liters
Trial 4	2 liters	.68 liters
Trial 5	2 liters	.70 liters

Experiment #2

A similar experiment was conducted at a different location. The conditions and data are included below.

- Regular soda (sugar)
- 5 Mentos® candies
- Elevation: sea Level
- External air temperature: 85 degrees Fahrenheit
- Internal liquid temperature: 70 degrees Fahrenheit

	Beginning Volume	Ending Volume
Trial 1	2 liters	1.23 liters
Trial 2	2 liters	1.18 liters
Trial 3	2 liters	1.28 liters
Trial 4	2 liters	1.25 liters
Trial 5	2 liters	1.21 liters

A. Observations. Write descriptive observations about the patterns you see in these two experiments.

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B. Considering the information recorded and data collected from both locations and observations above, construct three (3) investigable questions as you can that when answered would determine the relationships among the many variables.

Consider the question stem (What effect would __________ have on ______________?).

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C. Evaluate your questions and determine ONE question that is a testable scientific question (independent and dependent variables) and relevant to the phenomena. Revise question as needed. Explain your reasoning for this question choice.

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D. Design an investigation plan based on your testable scientific question chosen in part C to produce data and/or evidence to answer your question about the variable tested in the system. Characterize each variable as dependent or independent and explain any variables to be controlled and why. Explain how will you measure your results.

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E. Extension: What laboratory equipment/tools might you need to conduct this investigation? Make a list of those items. How might these tools help you make appropriate measurements and decrease errors?

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