Science Assessment System
Through Course Task

Burning Candle

Grade Level:
7

Phenomena:
Candle Wax Seems to Disappear When a Candle Burns

Science & Engineering Practices:
Developing and Using Models
Constructing Explanations and Designing Solutions

Crosscutting Concepts:
Energy and Matter

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.

Burning Candle Task Annotation

After **developing a model** about *the chemical reaction of a burning candle*, **use it to construct an explanation** for why the candle wax disappears, using the flow of matter in the system to support your explanation.

Phenomenon within the task

When a candle burns, some (or all, depending on the type of candle) of the wax seems to "disappear." However, the wax is changed to other forms of matter (mostly gases that are not visible). Matter is conserved even though it changes forms and may not be visible.

How the phenomenon relates to DCI

MS.PS1.B Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)

5.PS1.B Chemical Reactions

- When two or more different substances are mixed, a new substance with different properties may be formed; such occurrences depend on the substances and the temperature. No matter what reaction or change in properties occurs, the total weight of the substances does not change.

What information/data will students use within this task?

Students will receive a sample chemical equation and three models of that reaction. The equation for baking soda and vinegar was chosen because students have some familiarity with it (even if only in the context of model volcanoes). The first two models are given so that students can see there is more than one way to correctly model this reaction. The two models show the same particles before and after the reaction. The first model shows how a student could model conservation of matter without knowing the exact particles. The second model shows all the actual particles involved and indicates that this student knew what those particles were. The intent is students see that all of the particles you start with have to be accounted for after the reaction. The third model shows students a model that doesn't demonstrate matter conservation. They will need to compare and contrast the three models to determine the characteristics of a model showing matter conservation. This equation supports thinking about the candle because students generally focus on the production of the fizzing and bubbling without considering other products from the reaction.

They will also receive the chemical equation for a burning candle. This reaction was chosen because students commonly think the wax has disappeared without considering the idea of matter conservation. They will need to connect the equation and models from the baking soda and vinegar reaction to the chemical reaction of a burning candle.

Ideas for setting up the task with students

Teachers can set the task up with students by discussing what a model is and what models do. Teachers can give students examples of models, such as a solar system model or a model of Earth's interior. They can then discuss with students why and how these models are useful. These models help us visualize extremely large things. On the other hand, models of chemical reactions help us visualize extremely small things. Models help us understand the structure, connections, interactions, etc. of phenomena.

Another important aspect of modeling that might be useful for students to have familiarity with is that the same concept or phenomenon can be modeled in different ways. One model is not necessarily "better" than another model because it has more complexity – it depends on the <u>purpose</u> of the model. <u>Purpose</u> can depend on the concept being modeled, but also the intended audience for the model, as well as other considerations.

Intent of the Task for Assessment

This task is designed to determine if students can create a model and use it to support an explanation for a phenomenon (chemical reaction) most have observed outside of science class: a burning candle.

Students are supported in developing an understanding for the concept of conservation of matter and modeling of chemical reactions by exploring provided models of a chemical reaction that is common to science classrooms: the baking soda and vinegar reaction. Students examine this chemical reaction with multiple models, and then record how the sample models do and do not demonstrate matter conservation.

Students then transfer this understanding for modeling a chemical reaction to show conservation of matter by creating a model for the burning candle reaction and record how their model demonstrates matter conservation. Asking the student to provide evidence for how their model supports the conservation of matter requires them to revisit a primary purpose of their model before proceeding to the next part of the task. Students will construct an explanation for what chemically happens to the candle wax during burning. They are prompted to make a claim, use their model as evidence, and provide reasoning.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Developing and Using Models

- Develop and/or use a model to predict and/or describe phenomena.

Constructing Explanations and Designing Solutions

- Construct an explanation using models or representations.

Energy and Matter: Flows, Cycles, and Conservation

- Matter is conserved because atoms are conserved in physical and chemical processes.

Success Criteria

- Student explains how each of the provided models either supports or does not support the concept of conservation of matter.
- Student creates a model for the burning candle reaction that demonstrates conservation of matter, and explains how the model supports conservation of matter.
- Student constructs an explanation for what happens to the wax when a candle burns, by making a claim and supporting that claim with evidence and reasoning, using their model of the candle burning reaction in their explanation.

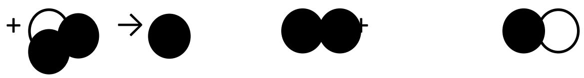
Possible Student Responses

What evidence is there in the sample models that matter is being conserved?

The matter is being conserved because the water, sodium acetate and carbon dioxide are all made up from the vinegar and baking soda. They are made of those same particles.

Why does the third model *not* show matter being conserved?
The number and type of particles on each side are not the same. If matter is conserved you should have the same particles on boths sides, just arranged differently.

In the following space create a model to represent this chemical reaction:
Wax + Oxygen → Carbon Dioxide + Water Vapor



What evidence is there that your model conserves matter during the chemical reaction?
The number of particles before and after burning is the same. The number of each type of particle is the same too. The only difference is they've been combined in different ways to make the new substances.

You will need to use your model of the candle chemical reaction to construct an explanation of where the candle wax goes during burning. You will need to include a claim, use your model as evidence, and provide reasoning linking the two.
The wax in the candle has been changed into new substances. My model shows the particles in the wax and oxygen that we start with. Then it shows the particles in the carbon dioxide and water vapor we end up with. There are the same number and type of particles. They've just been combined in new ways to make new substances. This means the stuff the wax was made of still exists, it's just been rearranged to form the carbon dioxide and water vapor. These are gases that we cannot see so it looks like the wax just disappeared.

Other information teacher teams might find useful when preparing to use this task in the TCT process
Chemical formulas are not used because students aren't being measured on their ability to model specific substances. Students are being measured on their ability to use models to describe the conservation of matter. Therefore, their models just need to show the same particles on each side of the reaction only arranged in different groupings.

If this task is used before instruction in chemical reactions some students may need more scaffolding with the task. You may need to clarify the expectations of the task, purposely drawing their attention to the three models and what they need to examine. Tailor your instructions to the needs of the students so they are able to independently process as much of the information as possible.

Then, once chemical reaction instruction has begun students can look back over their answers and compare them to current understanding.

If this task is used during or after instruction students should need less direction and be more self sufficient. The results of the task can also be used to diagnose student ideas/misconceptions while in the middle of instruction, and allow you to make midcourse corrections.

Extensions and/or other uses after the task is implemented

The results of this task can be used in the following ways:

1. The focus can be on the explanation (so the teacher gives more guidance on the modeling) and it can be used as a checkpoint to return to at a later date and compare with more recent explanations. Students can analyze both explanations and determine where they've improved and what needs continued work.
2. The modeling part of the task can serve as an introductory assessment on conservation of matter understanding. Students can then come back to these results after more instruction and identify mistakes and not corrections they can now make.
3. Students will model the reaction in different ways. The teacher can take different models and have students compare them to determine similarities and differences, as well as identify how each model fulfills the requirements of a good model. The teacher could select correct and incorrect models to facilitate discussion of strong and weak work.
4. The models can be used to discuss how well they convey mass conservation. Does one model have an advantage over another? What about the task puts constraints on the model? What if the sample models looked like this (select a different format of a mass conservation model), how would that affect the model you produced?

This task can serve multiple purposes in the classroom. It provides an opportunity for students to engage in a rich thinking experience that produces evidence. That evidence can then be analyzed by both teacher and student and used to make thoughtful, purposeful decisions on next steps in learning.

Through Course Task – Burning Candle

Part A –

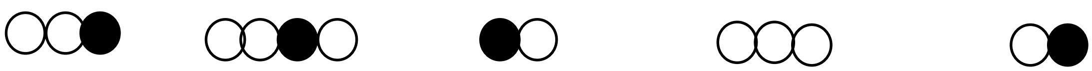
A chemical reaction occurs when you take substances and combine them to create new substances. The new substances are made of the same atoms as the old substances, they've just been grouped into different combinations. In a chemical reaction no atoms are created or destroyed, they are only connected in new ways to make new substances. An example of a chemical reaction would be combining vinegar with baking soda and producing water, sodium acetate and carbon dioxide. We could write this as:

Vinegar + Baking Soda → Water + Sodium Acetate + Carbon Dioxide

Models are representations that help us understand unfamiliar or confusing concepts. The following students used models to show they understand the idea that matter is conserved in a chemical reaction.

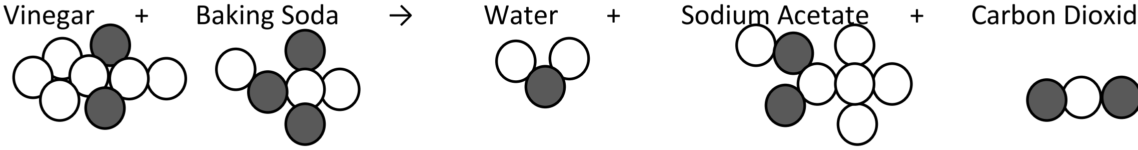
The first student wasn't sure which atoms make up these substances. He created the following model to show that he understands conservation of matter even if he didn't know the exact formulas for the substances.

Vinegar + Baking Soda → Water + Sodium Acetate + Carbon Dioxide



A second student knew the atoms in each substance and made this model. Her model also shows conservation of matter.

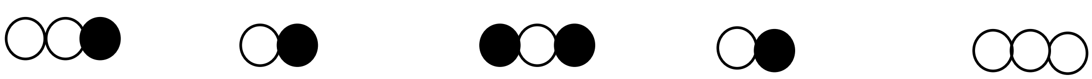
Vinegar + Baking Soda → Water + Sodium Acetate + Carbon Dioxide



These two models are different based on the student's understanding of the atoms contained in each substance. However, each model is able to demonstrate conservation of matter.

A third student was unsure which atoms make up these substances and created the following model.

Vinegar + Baking Soda → Water + Sodium Acetate + Carbon Dioxide



This model does **not** demonstrate conservation of matter.

1) What evidence is there in the first two sample models that matter is being conserved?

____

____

____

____

____

____

2) Why does the third model *<u>not</u>* show matter being conserved?

____

____

____

____

____

____

Another chemical reaction that you are familiar with is a candle burning. During this chemical reaction wax combines with oxygen to produce carbon dioxide and water vapor. We could write this as:

Wax + Oxygen → Carbon Dioxide + Water Vapor

In the following space create a model to represent this chemical reaction:

3) What evidence is there that your model conserves matter during the chemical reaction?

____

____

____

____

____

____

____

____

Part B –

Burning candles are interesting because they are a science phenomenon that we encounter often. Who hasn't thought about where the wax goes in a candle? "It evaporates!" "No, it melts." "The wax just disappears." The goal of science is to construct explanations for the causes of phenomena. Each of these responses is a claim that seeks to answer the question of what happened to the wax. When we make claims we need to provide evidence to support them.

You will need to use your model of the candle chemical reaction to construct an explanation of what happens to candle wax during burning. You will need to include a claim, use your model as evidence and provide reasoning linking the two.

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____