Lesson Overview: Burning Magnesium Post-Lab
LaSovage
This post lab activity takes 2-3 class sessions.

Background:
This lesson is the post-lab activity for the “Burning Magnesium” Lab. In this lab, students heated samples of magnesium metal in crucibles using Bunsen burners. Students observed that the material in the crucible had a greater mass after heating than before heating. At the conclusion of the lab, teams shared data in a combined class data table (electronic) and it has been observed that every group experienced an increase in mass. (Each student’s prediction was previously entered into the same table during a pre-lab activity, and only a small number predicted an increase in mass.) At this point, students have not been told the chemical contents of the crucible, but are now asked to develop explanations of why the mass increased.

Activity:

Part 1: Developing models/Identifying ideas
Students answered (individually, in their notebooks) a response to “Why did the mass increase?” They were required to include a written explanation as well as a diagram that helps support their explanation.

When finished (and directed to do so by teacher), students shared answers with members of their table teams. They were instructed to come up with a single group answer using discourse (not by voting). Students were required to discuss for a minimum of five minutes before getting a whiteboard on which they recorded their team answer. On the whiteboard, teams were required to include data, an explanation, and a diagram.

At the end of this session or the beginning of the next, students are asked whether this is a question that will have one correct answer or whether it is the type in which multiple answers are possible. [Anticipated:] Students agree that there is likely one “correct” explanation, but acknowledge that at this time we will likely see multiple answers on the whiteboards. (The class also agrees that this is okay at this point, but that eventually we will come to agreement based on the evidence.)

Part 2: Defending and critiquing ideas/Clarifying thought/Linking past knowledge
The class is arranged into a semi-circle shape. Each team presents their whiteboard answer to the class. To each team, other students (and teacher) ask questions, seek clarification and elaboration, compare ideas (etc.). During this part of the lesson all students are also recording ideas and thoughts into a section of their notebook headed “Discussion notes.” Talk prompts and other discourse practices are modeled and used by students during this full-class activity. Periodically, the class pauses and reviews ideas that we have had so far, including identifying which ideas have been dismissed and which are still in play as possible valid explanations.
During the discussion, teacher should be free to allow for experimentation as appropriate to test various hypotheses or gather data. Example: One class session weighed a Poptart before and after “crushing” it to test whether the crucible product weighed more due to being crushed.

At the conclusion of the presentations (or at the end of the first class hour), students are asked to answer this question to complete individually in their notebooks. “Is the material in the crucible after burning still magnesium? Explain your reasoning.”

**Part 3: Refining visual models**

[Part 3 may take place seamlessly with Part 2 or Part 4 depending on timing. Some of the questioning during Part 2 also prepares students for the ideas of this portion of the lesson. E.g. In addition to discussing teams’ conceptual ideas, diagrams on whiteboards were also reviewed, questioned and compared, focusing in particular on the idea each diagram was representing and what concepts of the ideas were and were not able to be derived from the diagrams.]

After briefly reviewing the ideas and conclusions of the previous session (if necessary), students were asked again to consider their diagrams. Specifically, whether a different kind of diagrammatic model could be helpful in allowing the class to draw a final conclusion of what occurred in the crucible. They were then directed to [p.33 (+/-) of] their notebooks to recall a previously-used model technique that utilizes circles to represent individual atoms. Students were asked to describe how we would model the “before” crucible contents using this model technique.

Once an appropriate “before” representation for the model was determined (as a class), students were asked to copy the following into their notebooks:

![Diagram](image.png)

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Students were then asked to use the same format to complete the diagram (i.e. to draw in the “after” portion.) [For some classes this was homework, for some this was in-class.]

Accountability: Class did not continue until all students had committed their idea into their notebook.

*Note: Fourteen Mg atoms were chosen to symbolize the fact that there is more than one atom of magnesium; it was acknowledged that the actual number would be too large to represent exactly.*
Part 4: Model Analysis

Once each student had his/her own answer, students were introduced to the next portion of the activity, namely that they would be provided with a set of samples that represented possible answers to this question. “In the folder are a number of different ideas of how to model what is in the crucible after heating. They are based on the ideas we came up with in discussion.” [Note: These diagram sets were prepared in advance based on student ideas from previous portions of this lesson and former experience with student conceptual understanding and misconceptions.] Students were told that most of them would likely find a sample that matched what was on their paper, although there is a blank included in case there is an answer significantly different.

Directions: “With your team, view all the possible models. Sort, arrange, eliminate, compare…until you come up with the model your team feels is the most accurate. Be able to discuss why.”

During this portion of the lesson, teams use various strategies to discuss the merits of each model. (Groups may take different time to complete the task. During this time, the teacher should circulate to answer questions and to ask students to describe their thinking.) As each group finished, they were directed to the second task of finding the worst representation. Teams then make a copy of their “best” and “worst” on two small whiteboards in preparation for the final sharing.

Part 5: Sharing Conclusions

Each team sent up two students, one with the whiteboard showing the “best” answer and one with the “worst.” Students stand in two lines (a best line and a worst line). (It is expected that the “best” line will contain mostly #12.) Students will briefly discuss why they chose this as the most accurate diagram to represent what was in the crucible. The worst line will likely have more variation. Again, students will share why they selected the diagram as the worst. Students may be asked whether one or both lines should have the same answer. [Expected results: best line should have consistency as it is based on fact and evidence; worst line may have variation as it is based on opinion and values.]

Closure:

At the conclusion of this discussion, students were asked to record (in writing, in their own notebook) the final agreed-upon diagram, and what was learned from this lab.

*Students should also have the accepted “After” diagram into their notebook and labeled as such.

Next Steps:

In the next lessons, the modeling format utilized in this lesson will be quantified and related to actual numbers of molecules and atoms in balanced and unbalanced equations. Students will be introduced to or review the law of conservation of matter and will begin to balance equations. For mathematically inexperienced students or those who need accommodation, the diagrammatic modeling will be an additional strategy for facilitating learning of this skill and related concepts.
Reflection:

*This reflection portion was originally used in a comparison activity within my building.*

There are a number of contribute to the effectiveness of this lesson sequence. One is the diversity of tasks. As students progress through the lesson sequence, they are involved in both introspective thinking as well as communication and argumentation. Through the learning cycles, students alternate between individual, group and whole class experiences. The physical arrangement of students and the room is also varied based on the task in order to emphasize a different priorities for each task. The transitions and variation allow for increased engagement as well as emphasis.

In this lesson, students are held accountable for their ideas, both individually and in teams. They are encouraged and allowed to interact and exchange ideas in an intentional manner, first in idea development and then in idea evaluation. In these, students are very clearly involved in the Science and Engineering Practices of NGSS. Research supports that the development of conceptual models and the discourse of ideas (as this lesson allows) promote deeper understanding of concepts and increased retention. Throughout the lesson, students’ ideas are discussed, not dismissed. This potentially increases students own learning motivation and ownership in the class. Additionally, revisiting our list of ideas and reiterating why each was ruled out (using evidence) or kept on as a possibility overtly reinforced how scientists use data to draw conclusions. (One student originally argued to “win” but his evidence was extremely flawed; we eventually came to the realization that argumentation in science must be done on a factual level, not a personal level, and letting go of a refuted idea helps move toward a more valid conclusion.)

Anecdotally, in checking student notebooks, the “what we learned” statements were sometimes simple, but very clearly rooted in the discussion. A number of students included, “I learned that ash is not on the periodic table.” In the initial large whiteboard session, a number of teams in each class cited the presence of ash as the reason the mass in the crucible increased. After the first discussions, this idea had not yet been ruled out (as water and changes in density had). However, through the use of the particle models in Part 4, students realized that this was not possible to model the ash idea using the rules of our “circle models” [i.e. each circle represents an atom; joined circles represent molecules]. Ruling out ash as a possible answer moved these students to the understanding that an increase in mass means an increase in atoms - in this case, oxygen from the room which had bonded to the magnesium in the crucible.

During an early balancing equation activity in a later class period, one of my students came up to the board and completed the atom count using the modeling format (instead of numerals). This demonstrates the integration of this post-lab activity to subsequent content and skill development.