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 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE"

Task 1

Throughout this two-part task, there is a heavy emphasis on reasoning with the DCI, while the SEP is often backgrounded.

SEPs DCIs SENSE-MAKING

Scenario 1: Ronda learned about the reactivity of metals in the first column of the periodic table. Her teacher demonstrated that the same amount of sodium (Na) placed in water is much more reactive than lithium (Li), which just fizzes-up a little.

Sodium in water.

Lithium in water.

This is a specific observation that contextualizes the task/this item; however, it is used more as a "hook" than a phenomenon that is explained throughout the course of the task (i.e., Questions A-C can be answered without any of the information provided by the scenario). While the relevance of this phenomenon is not made immediately clear to students, it is presented as something intriguing that could warrant an explanation. The scenario is short and includes images to help ensure all students understand the scenario.

SCENARIOS EQUITY

UNIT 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE" (CONTINUED)

Ronda wondered why, at the atomic level, the reaction of sodium and water was so much more violent than that of lithium and water.

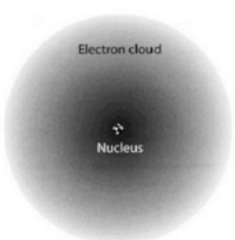
This is a clear attempt to establish, for students, 1) what uncertainty the task should address (i.e., why the two reactions are so different) and 2) cues to focus student thinking around which DCIs will be most relevant for the task (e.g., words like "atomic level" and "reaction").

SCENARIOS EQUITY

To help her explain this, let's begin with an atomic-level representation:

A. This is a representation of sodium. To the right of this representation draw an atomic-level picture of lithium that shows the size of lithium relative to sodium.

Sodium (Na) Lithium (Li)



This is a nice scaffold to help students first begin considering a representation of lithium. While this question itself is more like a recall question rather than one that requires sense-making, the task is clear about this: by using words like "representation" and "atomic-level representation", the task writer is distinguishing between a true model and just a picture of lithium—and making it clear that the latter is the goal. A question like this, used sparingly, can be helpful to establish how to interpret future responses from students (i.e., are students getting questions wrong because they don't know what to include in an atomic level representation?).

SEPs DCIs SENSE-MAKING

The highlighted aspect of the question could easily be a recall question, especially since students aren't given the periodic table. It's possible that students can draw this based on knowing the patterns of the periodic table, and therefore how the size of lithium differs from sodium (part of HS.PS1.A), but as written, the question seems to require that students have memorized the periodic table, which is not an expectation of the NGSS.

DCIs

Achieve

UNIT 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE" (CONTINUED)

B. Predict whether the energy required to remove an electron from lithium would be more or less than that required to remove an electron from sodium.

To successfully respond to this question, students need to understand how the atomic substructure of sodium is different than lithium, and how this relates to the energy required to remove an electron from each atom. While this is certainly related to patterns of atomic structure and chemical properties of atoms (part of HS.PS1.A), it's unclear from the question itself how students are supposed to know about the structure of lithium relative to sodium—as written, rote understanding is just as likely as interpreting patterns in the periodic table (from memory). The task would be stronger if students were given a periodic table to work with.

In this question, students are sense-making with part of HS.PS1.A: "each atom has a substructure consisting of a nucleus, which is made of protons and neutrons, surrounding by electrons...the periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns...".

DCIs SENSE-MAKING

Explain your prediction in terms of the forces and interactions involved in this process.

Although the word "explain" is used here, the prompted student response is closer to a description of DCI understanding than a true scientific explanation, because no evidence is cited—what is really expected is that students make their reasoning, grounded in DCI, visible.

SEPs

The representation you constructed in part A should be helpful here.

UNIT 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE" (CONTINUED)

C. The relative ease with which an electron is transferred away from a metal determines how reactive that metal is with water.

This is important contextual information to provide to students so that they can make the requested prediction.

SCENARIOS

Given this, predict whether rubidium (Rb) would be more or less reactive in water than sodium. Explain your prediction in terms of the forces and interactions involved in removing an electron from an atom. representation you constructed in part A should be helpful here.

If students are given the periodic table, this requires that they demonstrate that they can use their understanding of HS.PS1.A to make a prediction. Students may also use their representation from part A as a simple model when they use it to make a prediction, connecting to part of the 6-8 Developing and Using Models element "[use] a model to show the relationships among variables, including those that are not observable but predict observable phenomena."

Students' responses are also an example of the HS CCC element "different patterns may be observed at each of the scales at which the system is studied and can provide evidence for causality in explanations of phenomena". This CCC is highly overlapping with the targeted DCIs, so it is difficult to be certain that students:
1) had the opportunity to learn patterns as a CCC (not only in the context of the targeted DCI), and
2) are bringing an understanding of patterns as an idea that holds true across science to the table as part of their reasoning.
Regardless, students' reasoning when they support their prediction will likely be more complete and sophisticated if they have facility with this CCC element.

DCIs CCCs SENSE-MAKING SEPs

UNIT 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE" (CONTINUED)

Scenario 2:

Although similar in set up to first task scenario, the phenomenon here—that magnesium does not result in a visible reaction when placed in water—is indeed addressed by the end of the task, making this scenario one that elicits a more multi-dimensional performance.

SCENARIOS

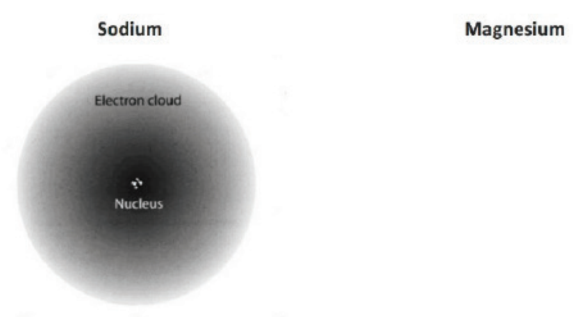
Ronda decided to investigate whether an element in the second column of the periodic table would react in a similar way when placed in water.

Ronda placed a piece of magnesium (Mg) in a beaker with water. There was no immediate, visible change. She wondered why the sodium was reactive in water, while magnesium, which is only one place to right of it in the periodic table, did not seem to react when placed in a beaker of water. To help Ronda think about this, let's again begin with an atomic-level representation.

This language hints that the periodic table can be given to students, and is not expected to be memorized. This scenario would be more effective if the periodic table was given.

SCENARIOS

A. Below is a depiction of sodium. To the right of this representation, draw an atomic-level picture of magnesium that shows the size of magnesium relative to sodium.



UNIT 2: PERIODIC TABLE TRENDS- "PERIODIC TABLE" (CONTINUED)

B. Explain why the relative size of the magnesium atom you drew in part A is reasonable. Include the forces and interactions that govern the size of an atom in your answer.

To answer this question (and draw an appropriate representation in part A), students need to understand 1) the patterns of atomic substructure embedded in the periodic table structure (part of HS.PS.1A), and 2) how forces and interactions among protons and electrons determine the relative size of the atom. This requires that students make their reasoning with the DCI visible.

DCIs | SENSE-MAKING

C. Bearing in mind that metal reactivity with water is determined by the ease of electron removal from that metal, provide an atomic-level explanation for why magnesium is less reactive than sodium when placed in water.

Students are asked to explain the phenomenon introduced in scenario 2.

To successfully answer this, students have to use the given observations about how magnesium and sodium reacted when placed in water with 1) their understanding of trends in atomic substructure and chemical properties reflected by the periodic table (part of HS.PS1.A), and 2) the idea that macroscopic observations are related to the nature of atomic-level structure (part of a 6-8 Cause and Effect element) as evidence and reasoning to support an explanation for the observations (part of the 3-5 Constructing Explanations element "use evidence (e.g., observations, patterns) to construct...an explanation...)". Because the explanation depends on very few sources of evidence, this does not reach the level of expectations described in the MS or HS elements of the SEP.

SENSE-MAKING | SEPs | CCCs | DCIs