Introduction

Formative Assessment Exemplar - 8.1.3

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

Of note: All formative assessment clusters were revised based on feedback from educators after being utilized in the classroom. During the revision process, each cluster was specifically checked to make sure the phenomena was authentic to the DCI, supporting information was provided for the phenomena, the SEPs, CCCs, and DCIs were appropriate for the learning progressions, the cluster supported student sensemaking through the Gather, Reason, and Communicate instructional model, and the final communication prompt aligned with the cluster phenomena. As inconsistencies were found, revisions were made to support student sensemaking. If other inconsistencies exist that need to be addressed, please email the current Utah State Science Education Specialists with feedback.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Info

Teacher Facing Information

Standard: 8.1.3

Assessment Format: Online Only (Requires students to have online access)

Phenomenon	
In the United States of America, the fourth of July is a celebration of its independence. Fireworks are a symbol of triumph. You wondered how every firework displays a variety of colors. Figure 1: Fireworks  "Fireworks in front of the Lincoln Memorial and Washington Monument" by WilliamMarlow is licensed under CC BY-NC-SA 2.0 Video clip on fireworks	Proficient Student Explanation of Phenomenon: The bright sparkles in fireworks come from adding heat to small bits of metal that release energy which indicate that a chemical reaction has occurred. Once the firework is in the sky, the properties of the metals used are changed and give off energy that we see as light, color or feel as heat or hear as sound.
Cluster Task Statement	
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed) In the questions that follow, you will analyze and interpret the data provided in order to identify patterns in the changes of a substance's properties to determine if a chemical reaction has occurred.	
Supporting Information	
The science of firework	

Informational Text

The basic firework requires three ingredients: oxygen, a fuel, and a chemical mixture. Oxygen causes fuel to burn to produce heat. The chemical mixtures are composed of a variety of elements. When different elements burn, their electrons are exposed to heat and they gain energy, which excites the electrons. When an electron cools off and returns to its un-excited state, it loses the energy it had gained. This energy is released as light.

When each of the elements burn, they produce a different color. For example, lithium and strontium carbonates produce deep reds and purples when they are burned. Copper chlorides produce blue. Titanium, aluminum and magnesium are silvery. Calcium chloride is orange, sodium is yellow and barium burns green.

Table 1: elements and the color they make when burned

element	color
Lithium and strontium carbonates	Deep red; purple
Copper chlorides	blue
Titanium, aluminum and magnesium	silver
Calcium chloride	orange
sodium	yellow
Barium	green

Figure 2: Chemical reaction of fireworks

Reactants **Products**

$$3\ KClO_4 + 8\ Al \rightarrow 3\ KCl + 4\ Al_2O_3 + \text{Heat and Light}$$

Figure 3: Pictures of Aluminum and Potassium Perchlorate

Aluminum (Al)
https://en.wikipedia.org/wiki/Aluminium

Potassium Perchlorate ($KClO_4$)
https://en.wikipedia.org/wiki/Potassium_perchlorate

Table 1: Chemical reaction for fireworks.

Reactants		Product	
Element	**Properties BEFORE launching firework**	**Properties of products AFTER launching firework**	**Energy Changes**
Aluminum (Al)	Solid Silver Malleable (capable of being shaped) non-flammable	White crystalline solid and Brown solid Not flammable	Produces white light Sound is produced Heat is produced
Potassium Perchlorate ($KClO_4$)	Solid White Non-malleable Flammable		

Your Task

In the questions that follow, you will analyze and interpret the data provided. You will identify patterns in the changes of a substance's properties to determine if a chemical reaction has occurred.

Cluster Questions

Gather: Cluster Question # 1 Question Type: Multi-Select Addresses: ✓ DCI: (PS1.A) Structure and Properties of Matter SEP ✓ CCC: Patterns **Answer:** Light Sound The addition of the statement "**in the video clip**" would prevent them from considering heat as an answer, because they aren't there to feel if it gets hotter. OR if you do not include it I feel like heat should also be an answer	Question 1: Video clip on fireworks Watch the short video clip on fireworks using the link above. What **types of evidence(s)** do you observe **in the video clip** that would show a chemical change has occurred? You may choose more than one answer. a. Heat b. Light c. Sound d. Electrical e. Nuclear
Gather: Cluster Question # 2	Question 2:

Question Type: Multiple Choice
Addresses:
✓ DCI: (PS1.A) Structure and Properties of Matter
✓ SEP : Analyzing and Interpreting Data
___ CCC : Patterns
Answer to revision question:

a. I would need to use: red- lithium and strontium carbonates, blue- copper chloride, and white/silver- titanium, aluminum and magnesium

Using the supporting informational text, decide which elements you would want to use to produce a firework show that only produces red, blue, and white/silvery fireworks.

A. I would need to use: red- lithium and strontium carbonates, blue- copper chloride, and white/silver- titanium, aluminum and magnesium
B. I would need to use: red- calcium chloride, blue- sodium, and white/silvery- copper chlorides
C. I would need to use: red- barium, blue- sodium, white/silvery- lithium carbonates
D. None of these combinations would produce only red, blue and white/silvery fireworks

Reason:
Cluster Question #3
Question Type: Multi-Select
Addresses:
✓ DCI: (PS1.A) Structure and Properties of Matter
✓ SEP: Analyzing and Interpreting Data
✓ CCC: Patterns
Answer:

	Yes	No
A new material is produced	x	
Sound is produced	x	
Electric is generated		x
Heat is produced	x	
Phase is changed		x
Light is produced	x	

Question 3:
Use Table 1 to help you fill in this table.
What effects does the chemical reaction of fireworks produce? Put a mark in the appropriate box to answer if the following occurred.

	Yes	No
A new material is produced		
Sound is produced		
Electricity is produced		
Heat is produced		
The product changes to a new state of matter		
Light is produced		

Reason:
Cluster question #4
Question Type: Short Answer
Addresses:
✓ DCI: (PS1.A) Structure and Properties of Matter

Question 4:
On the Fourth of July, you and your friend go to a firework show. You and a friend talk about which color was your favorite during the fireworks show. You prefer the purple colored fireworks, while your friend prefers the green fireworks. What is the difference in the fireworks that cause the different colors you saw?

✓ SEP: Analyzing and Interpreting Data ✓ CCC: Patterns Answer: The colors depend on the element's properties when burned. The purple color comes from lithium and strontium carbonates. The green color comes from barium.	
Communicate: Cluster Question # 4 Question Type: Long Answer Addresses: ✓ DCI: (PS1.A) Structure and Properties of Matter ✓ SEP: Analyzing and Interpreting Data ✓ CCC: Patterns Answer: Answer: Claim: should not start with yes or no, should not include any data, evidence, or reasoning. Should be a statement that answers the question EX: Fireworks are/aren't an example of a chemical change. Evidence: will vary, but using table 1, they could include: new substances are made, light is produced, sound is produced, and heat is produced. Reasoning: will vary, but should tie together how the evidence supports their claim.	Question 5: **Claim, Evidence, Reason** Write a **claim** that answers the question: "Are fireworks an example of chemical changes?" Support your claim with at least 3 pieces of **evidence** from the readings, videos, or tables provided throughout this assessment, and make sure to include ample reasoning as to why your evidence supports your claim.
Proficiency Scale	

Proficient Student Explanation:
The bright sparkles in fireworks come from adding heat to small bits of different elements that release energy which indicate that a chemical reaction has occurred. Once the firework is in the sky, the properties of the elements used are changed and give off energy that we see as light or feel as heat or hear as sound.

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	Represent data in tables and/or various graphical displays to reveal patterns that indicate relationships. Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected in order to discuss similarities and differences in their findings.	~~A~~nalyze, and/or interpret graphical displays of data ~~to~~ identify linear and nonlinear relationships. Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. Distinguish between causal and correlational relationships in data. Analyze and interpret data to provide evidence for phenomena. Analyze and interpret data to determine similarities and differences in findings.	**SEP:** Extends beyond proficient in any way.
CCC: Does not meet the minimum standard to receive a 2.	Uses similarities and differences in patterns to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.	Identifies that macroscopic patterns are related to the nature of microscopic and atomic-level structure.	**CCC:** Extends beyond proficient in any way.

	Uses patterns of change to make predictions. Uses patterns can as evidence to support an explanation.	Uses patterns to identify cause and effect relationships. Uses graphs, charts, and images to identify patterns in data.	
DCI: Does not meet the minimum standard to receive a 2.	When two or more different substances are mixed, a new substance with different properties may be formed.	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. Some chemical reactions release energy, others store energy.	**DCI:** Extends beyond proficient in any way.

(Student Facing Format on following page)

Student Assessment

Name: _____ Date: _____

Stimulus

In the United States of America, the fourth of July is a celebration of its independence. Fireworks are a symbol of triumph. You wondered how every firework displays a variety of colors.

Figure 1: Fireworks

Video clip on fireworks

Informational Text

The basic firework requires three ingredients: oxygen, a fuel, and a chemical mixture. Oxygen causes fuel to burn to produce heat. The chemical mixtures are composed of a variety of elements. When different elements burn, their electrons are exposed to heat and they gain energy, which excites the electrons. When an electron cools off and returns to its un-excited state, it loses the energy it had gained. This energy is released as light.

When each of the elements burn, they produce a different color. For example, lithium and strontium carbonates produce deep reds and purples when they are burned. Copper chlorides produce blue. Titanium, aluminum and magnesium are silvery. Calcium chloride is orange, sodium is yellow and barium burns green.

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sodium	yellow
Barium	green

Figure 2: Chemical reaction of fireworks

Reactants **Products**

$$3\ KClO_4 + 8\ Al \rightarrow 3\ KCl + 4\ Al_2O_3 + \text{Heat and Light}$$

Figure 3: Pictures of Aluminum and Potassium Perchlorate

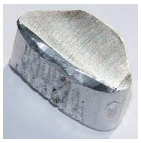 Aluminum (Al) https://en.wikipedia.org/wiki/Aluminium	 Potassium Perchlorate ($KClO_4$) https://en.wikipedia.org/wiki/Potassium_perchlorate

Table 1: Chemical reaction for fireworks.

Reactants		**Product**	
Element	**Properties BEFORE launching firework**	**Properties of products AFTER launching firework**	**Energy Changes**
Aluminum (Al)	Solid Silver Malleable (capable of being shaped) non-flammable	White crystalline solid and Brown solid Not flammable	Produces white light Sound is produced Heat is produced
Potassium Perchlorate ($KClO_4$)	Solid White Non-malleable Flammable		

Your Task

In the questions that follow, you will analyze and interpret the data provided. You will identify patterns in the changes of a substance's properties to determine if a chemical reaction has occurred.

Question 1

Video clip on fireworks (Watch the short video clip on fireworks using the link)

What **types of evidence(s)** do you observe **in the video clip** that would show a chemical change has occurred? You may choose more than one answer.

a. Heat
b. Light
c. Sound
d. Electrical
e. Nuclear

Question 2

Using the supporting informational text and chart, decide which elements you would want to use to produce a firework show that only produces red, blue, and white/silvery fireworks.

A. I would need to use: red- lithium and strontium carbonates, blue- copper chloride, and white/silver- titanium, aluminum and magnesium
B. I would need to use: red- calcium chloride, blue- sodium, and white/silvery- copper chlorides
C. I would need to use: red- barium, blue- sodium, white/silvery- lithium carbonates
D. None of these combinations would produce only red, blue and white/silvery fireworks

Question 3

Use Table 1 to help you fill in this table.
What effects does the chemical reaction of fireworks produce? Put a mark in the appropriate box to answer if the following occurred.

	Yes	No
A new material is produced		
Sound is produced		
Electricity is produced		
Heat is produced		
The product changes to a new state of matter		
Light is produced		

Question 4:

On the Fourth of July, you and your friend go to a firework show. You and a friend talk about which color was your favorite during the fireworks show. You prefer the purple colored fireworks, while your friend prefers the green fireworks. What is the difference in the fireworks that cause the different colors you saw?

Question 5

Write a **claim** that answers the question: “Are fireworks an example of chemical changes?”
Support your claim with at least 3 pieces of **evidence** from the readings, videos, or tables provided throughout this assessment, and make sure to include ample reasoning as to why your evidence supports your claim.